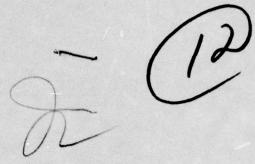
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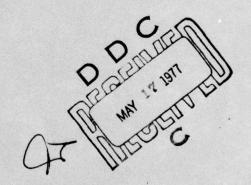




A TIME DOMAIN PROGRAM FOR WIRE ANTENNA ANALYSIS

John Potenza

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ROME AIR DEVELOPMENT CENTER AIR FORCE SYSTEMS COMMAND GRIFFISS AIR FORCE BASE, NEW YORK 13441

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FRANK J. REHM

Asst Chief, Surveillance Technology Branch

Surveillance Division

APPROVED:

Joseph L. RYERSON

Technical Director Surveillance Division

FOR THE COMMANDER:

JOHN P. HUSS Acting Chief Plans Office

John J. Huss

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#### PREFACE

The analysis presented in this report was performed under Job Order 45060471.

The author wishes to thank Mr. Donald Harvey for his assistance and criticism in the reduction of data and preparation of the report.

In addition, the author wishes to acknowledge and thank Miss Jane Basenfelder/TIPN for the excellent reproduction of the measured data and the original art work contained in the report.



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#### INTRODUCTION

The purpose of this report is to discuss a useroriented computer routine\* to analyze wire-type antennas
directly in the time domain. Instructions for program
input data and interpretation of the output are presented
in concise form to permit use of the program with minimum
theoretical understanding. Sample cases are presented
which walk the reader through a typical problem solution.
The computed results are critically compared with published
experimental results to establish the validity of the computer
routine.

The time domain approach is the most direct way to obtain the response of an antenna to a transient excitation. The output of the time domain solution is a time history of the current distribution on the antenna caused by a transient voltage or field excitation. Integration of this current provides the time varying far field or the receiving response of the antenna. By using Fourier transform the results can

<sup>\*</sup>The computer routine was developed by ME Associates and has been implemented on computers at RADC, NRL, and NAVSEC under contract N00014-73-C-0099 and RADC F30602-72X0008.

be expressed in the frequency domain as the wide band response of the antenna. A single time domain solution yields data over the bandwidth associated with the time waveform of the excitation.

This report is divided into three parts. First a general description of the formulation is provided. Then program input and instructions for using the computer routines are given, including preparation of input data and interpretation of output for a specific example.

Finally the output is discussed and critically compared with experimental results. A listing of the Fortran source program is included as Appendix A.

SECTION I Formulation of the Time Domain Equations

1.0 For the sake of completeness and providing a self-contained report, this section presents without rigorous derivation the integral equations which were developed and used in the Time Domain Program by MB Associates under government contract<sup>1</sup>.

This computer routine is based upon the time domain equivalent of Packlington's Integral equation which is widely used for frequency domain numerical solutions. In the time domain the equation becomes an integrodifferential equation and the unknown current is a function of two variables, position and time. The time domain equation can be derived by using Maxwell's time varying equations and the representation of the electric field in terms of the vector and scalar potentials and introduction of the retarded potential. Consider the general antenna structure depicted in Figure 1.1.

The electric field at an arbitrary point P  $(\bar{r}, \theta, \phi)$  outside the volume current and charged source V' is expressed as

$$\overline{E}$$
  $(\overline{r},t) = - \nabla \phi (\overline{r},t) - \frac{\partial}{\partial t} \overline{A} (\overline{r},t)$  (1)

where 
$$\overline{A}(\overline{r},t) = \frac{\mu}{4\pi} \int_{\overline{C}} J(\overline{r},t-R) dv'$$
 (2)

$$\phi(\overline{r},t) = \frac{1}{4\pi\epsilon} \int_{V'} \frac{\rho(\overline{r'},t-\frac{R}{C})}{R} dv'$$
 (3)

are the retarded vector and scalar potentials at point  $P(\overline{r}, \theta, \phi)$  respectively and

 $J(\overline{r}', t') = current density in Volume V'$ 

 $\rho$  ( $\overline{r}'$ , t') = charge density in volume V'

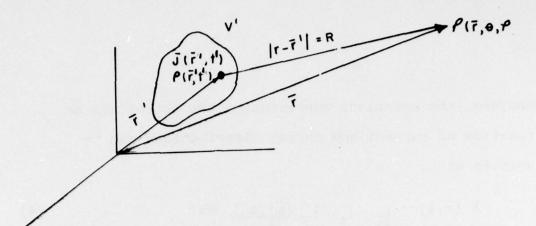
C = velocity of light

 $t' = t - \frac{R}{C}$  = retarded time

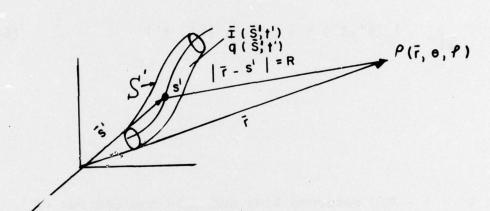
In the above expressions, the primed quantities represent source coordinates and the unprimed represent the field point.

If one considers a thin wire structure the current and charge are now confined to a filamentary path on the wire axis and the integration represented in equations

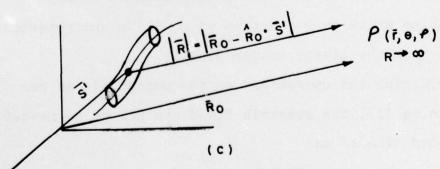
(2) and (3) reduce to contour integrals along the wire axis.



FIELD DUE TO VOLUME CURRENT & CHANGE



FIELD DUE TO FILAMENT OF CURRENT & CHANGE
(b)



FARFIELD APPROXIMATIONS
Figure 1. 1

Therefore, the equations representing the potentials as a function of current and charge distributions can be rewritten as

$$\overline{A}(\overline{r},t) = \frac{\mu}{4\pi} \int_{\mathcal{L}} \frac{\underline{I}'(\overline{s}',t')}{R} ds'$$
 (4)

$$\phi (\overline{r},t) = \frac{1}{4\pi \epsilon} \int_{\mathcal{R}} \frac{q(\overline{s}',t')}{R} ds'$$
 (5)

$$\frac{\partial}{\partial s'} \qquad I \quad (\overline{s}', t') = -\frac{\partial}{\partial t'} \quad q \quad (\overline{s}', t')$$
 (6)

where t' = t - R/C retarded time and  $\ell$  is the contour of the wire,  $\overline{s}'$  is the source position vector at point s' (See Figure 1.1b). I  $(\overline{s}', t')$  is the unknown current distribution which is a function of position and retarded time and  $\mathbf{q}$  is the linear charge density.

Performing the operations on the potentials as required in eq (1), the electric field can now be expressed in retarded time t' as:

$$\overline{E}(\overline{r},t) = -\frac{\mu \hat{s}'}{4\pi} \int_{\ell} \left[ \frac{1}{R} \frac{\partial}{\partial t'} I(s',t') + \frac{C\overline{R}}{R^2} \frac{\partial}{\partial s'} I(s',t') \right] ds'$$

$$+C^2 \frac{\overline{R}}{R^3} \frac{\partial}{\partial s'} \int_{0}^{t} I(s',t')dt' dt' ds' \qquad (7)$$

where s' is unit vector tangent to wire at s'.

If now, R  $\rightarrow \infty$  and only those terms are retained which decrease as 1/R, equation (7) reduces to the farfield expression

$$\overline{E}(\overline{r},t) = -\frac{\mu \hat{s}'}{4\pi} \int_{\Omega} \left[ \frac{1}{R} \frac{\partial}{\partial t'} I(s',t') + C \frac{\overline{R}}{R^2} \frac{\partial}{\partial s'} I(s',t') \right] ds' (8)$$

Since R  $\rightarrow \infty$  R can be replaced by  $\overline{R}_0$ , the vector from the point of observation to the origin (See Figure 1c), and using

$$\frac{\partial}{\partial s'} \quad I(s',t') = \frac{d}{ds'} \quad I(s',t') - \frac{\hat{R}_0 \cdot \hat{s}'}{C} \quad \frac{\partial}{\partial t'} \quad I(s',t') \quad (9)$$

The far field formulation can be written as

$$\overline{E}_{r}(\overline{r},t) = -\frac{\mu l}{4\pi R_{o}} \int_{\ell'} \frac{\partial}{\partial t'} I(s',t') \left[\hat{s}' - (\hat{s}',R_{o}) \hat{R}_{o}\right] ds' \quad (10)$$

Equation 10 is the final form of the integro differential equation for the radiated field. It is obvious that if the current on the antenna is known both as a function of position and time, it is a relatively simple matter to compute the field or received response. The crux of the computer routine herein is the computation of the induced currents. While no attempt will be made in this report to develop the numerical techniques employed, a general outline of the concept follows.

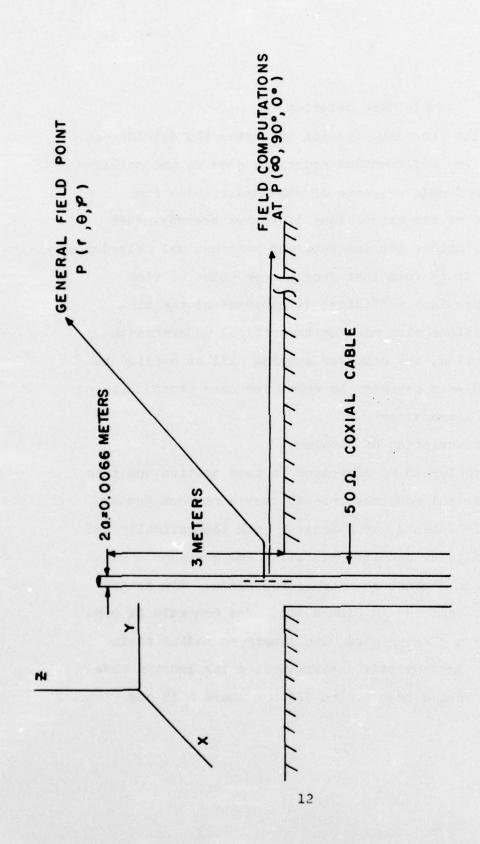
The method of moments(1) is used to reduce equation (7) (with appropriate boundary conditions) to a set of linear equations to solve for the unknown current, involving both position and time rather than the single variable positions as occurs in the frequency domain. Subsectional collocation methods are applied to solve the linear equations for current coefficients. This requires that the antenna structure be divided into a number of segments and time be divided into equal increments. The details of the numerical techniques will not be presented here because of their complexity. However, the effects of the numerical techniques are to compute the current (position and time) at the center of each subsection

due to impressed excitation. Once these currents are computed the total field is determined through equations (8) through (10).

### SECTION II Sample Case Solution

- 2.0 The preceding section presented the development of the integro differential equations used in the solution of the time domain response of antennas. While the development of the expressions is rather sketchy, they suffice to outline the concepts and mathematical procedures employed. It is felt that from a user point of view Section I provides sufficient development of the time domain equations with minimum theoretical understanding. In this section, the computer routine will be applied to a simple antenna geometry to emphasize user procedures and data input preparation.
  - 2.1 Description of Problem.

The problem to be addressed in this section consists of a cylindrical monopole antenna over a perfect ground plane. This antenna was addressed both theoretically and experimentally by Schmitt, et. al., and provides a meana of comparison against computed performance. The actual geometry is depicted in Figure 2.1. The monopole is represented by a 3 meter wire with length to radius ratio h/a = 904. In Schmitt's experiments, pulse lengths were used which varied from 0.2 to 2.0 h/c where h is the



THIN CYLINDRICAL MONOPOLE OVER GROUND PLANE Figure 2.

length of the wire and c is the velocity of light. The rise time for the pulses is 0.05 h/c. The excitations considered are voltage sources to obtain the radiated field response and field excitations to examine receiving time domain performance. The excitations are short base band time waveform voltage and field excitations. The time characteristics of the excitations are 3 db width of 0.16 h/c and 2.0 h/c with rise time on the order of 0.05 h/c.

## 2.2 Data Input.

In order to input this problem into the Time Domain (TIMDOM) program the problem must be cast into input data format. The input data can be separated into six categories.

- 1. Comments
- 2. Data
- 3. Geometry

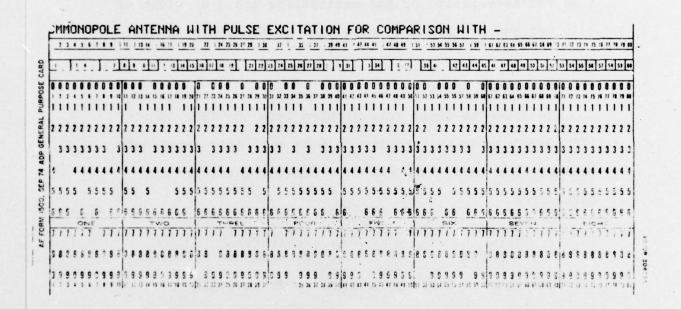
- 4. Loading
- 5 Excitation
- 6. Output Data requests

The data is input as punched cards and will be described in the following paragraphs as applied to the example problem.

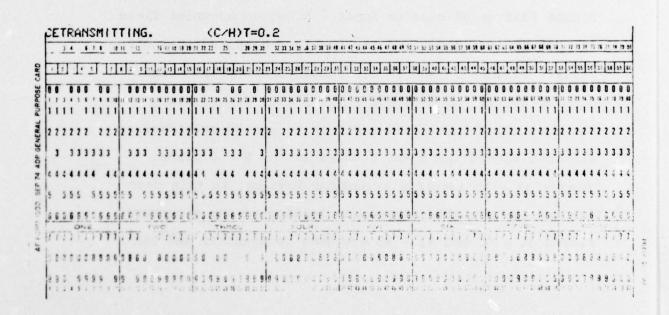
#### 2.2.1 Comment Cards.

The data card deck must begin with one or more comment cards which may contain a description of the

problem or any other pertinent information. Each comment card must begin with the mnemonic CM and the contents of the card in columns 3 through 80 are printed in the output. All comment cards are read serially and <u>must end</u> with a card with mnemonic CE. This flags the end of comment cards.



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#### 2.2.2 First Data Cards.

This card does not contain a mnemonic identifier.

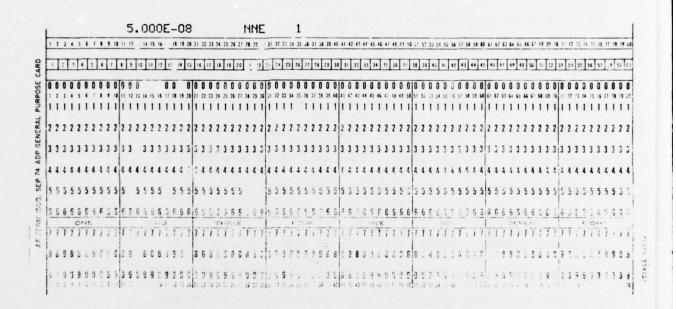
The contents of the card are divided into 7 usable fields from column 1 through 45. The parameters included on the card are: Time increment for solution (TI); Maximum time for which currents are computed (TMAX); Number of time steps for solution (NS); Symmetry planes if any; Structure loading if any (SL); and type of loads. See card below for specific example.

Fields 1 - 10 are blank, thus not specifying TI. However, its value is computed automatically by making it slightly larger than the maximum segment length/c. The integer number occupying field 11 - 20 specifies TMAX.

Either TMAX or NS must be input. NS which occupies field 21 - 25 is left blank and is therefore computed automatically. Columns 26 and 27 are unused on this data card. Columns 28, 29 and 30 specify the planes of symmetry. For the case being considered the E in column 30 specifies an electric conducting plane located at the Z = 0 plane.

Fields 31 - 35 identify structure loading, in this case the one (1) signifies impedance loading on the structure.

those segments of the wire antenna for which currents are to be printed. In this case where they are left blank, currents will be printed for all segments as a default condition.



### 2.2.3 Geometry Cards.

The purpose of the geometry cards is to input the antenna structure geometry. Specifically these cards (mnemonic)

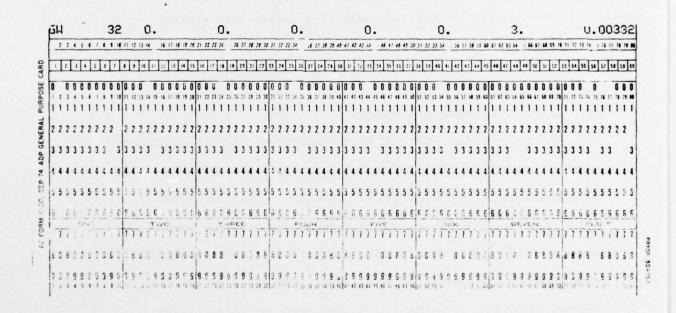
GW generate lengths of straight wire between two points in space and divide them into an equal number of segments.

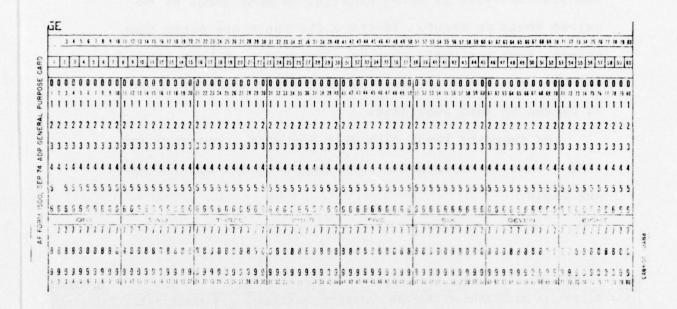
The card is divided into 10 fields which are used to identify the end points of the wire (in x, y, z space), identify the number of segments, and provide the radius of the wire. Any number of wires can be generated in this fashion, however, only a single wire can be generated on one card.

See specific example below for detailed description of the data fields. Fields 3 - 5 are used to identify, by tag number, a segment of the wire for later use if needed. In this case, no segment is tagged since the antenna is composed of a single wire. Fields 6 - 10 are used to specify the number of segments into which the wire is to be divided, in this case 32. Three fields are distributed between columns 11 and 40 which are used to specify the x, y, z coordinates of one end of the wire. In this case the wire end is positioned at the origin. Columns 41 - 70 are used to specify the other end of the wire. The data in column 64 places the wire 3 meters along the Z axis. See Figure 2.1. Fields 71 - 80 are used to specify the radius of the wire in this case 0.00332 meters. Since this case only involves a single wire antenna only one Geometry card is used. If a more

complex structure is being modeled, as many cards as required would be input. If the units input are other than meters, then the units must be converted to meters through the use of a structure scaling card (GS). However, none is needed in this case deck.

The geometry input data <u>must end</u> with a geometry end card. This is represented by mnemonic GE and all fields are blank.

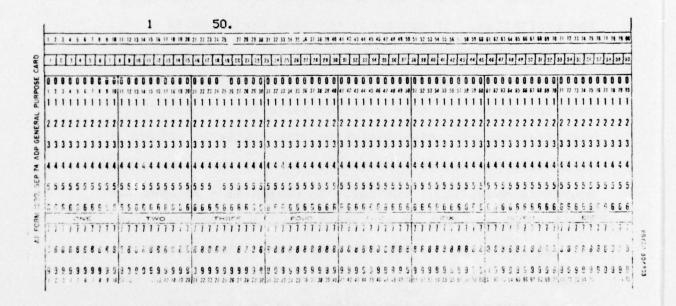




## 2.2.4 Impedance Loading.

If an antenna structure is impedance loaded, allowance must be made for inputting the data into the program. This is accomplished by a group of impedance loading cards. This card is divided into six usable fields which are used to identify the wire segments to be loaded and specify the complex impedance of the load. See card below for format details. Fields 1 - 5 are used to specify the number of impedance cards. If non zero, the program

searches for succeeding loading cards. In this case that field is zero implying this is the last impedance loading card. Fields 6 - 10 and 11 - 15 are used to identify, by tag number, the segment to be loaded. In this case segment one (1) is identified. Fields 21 - 30, 31 - 40, 41 - 50 are used to specify in ohms the resistance, inductance, and capacitance of the impedance. In this case, a 50 ohm pure resistance is input to simulate the coax feed point impedance.



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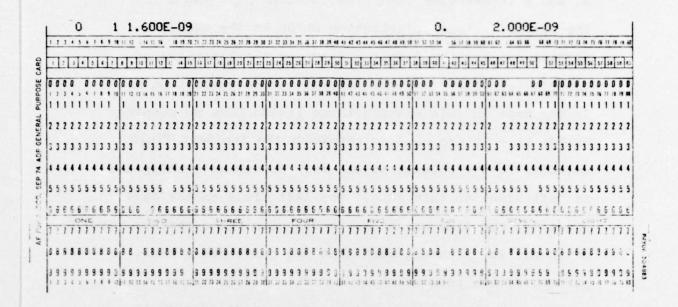
#### 2.2.5 Excitation Card.

Having described the geometry and loads, the excitation must be specified. This information is input through the excitation card. It is divided into 8 fields which are used to specify type of excitation, i.e. voltage or field excitation; number of sources; 3 db pulse width of the excitation; incidence angle for field excitation. A discussion of the various fields references the excitation card of the example case.

Fields 1 - 5 are used to identify the time variation of the excitation. If non zero, the time variation is arbitrary and the value appearing in this field specifies the number of values to be read from succeeding Source Function cards. In this case the value zero in the field specifies Gaussian time variation. The fields in columns 5 - 10 specify the number of sources. In this case one voltage source is specified. The value in Fields 11 - 20 specifies the 3 db pulse width of the excitation, i.e. 1.6 ns which is equivalent to 0.16 h/c for this case. Three fields in columns 21 - 30, 31 - 40, 41 - 50 are used to specify the 9, Ø, n parameters of the incidence angle for field excitation. The field source position is specified by

 $\Theta$ , and  $\emptyset$  (convention spherical coordinates), and  $\eta$  is the electric field polarization which is the angle in degrees between the  $\Theta$  unit vector and the direction of the electric field. For a voltage source excitation as is the case in this example these fields have no meaning. Fields 51-60 are used to reference the incident field relative to the antenna structure. It has no meaning and is left blank in this case. The last field on the card specifies the time at which the Gaussian pulse reaches its maximum. It is chosen such that the pulse has a small percent of its peak value at t=0. If left blank, the program computes an appropriate value =3% of peak at t=0). In this case it was specified. This card completely specifies all the parameters required to input the excitation.





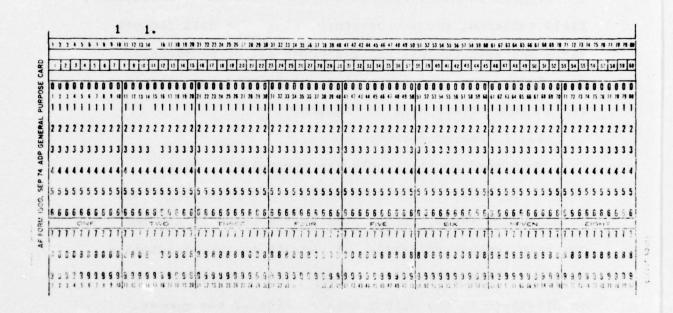
## 2.2.6 Source Voltage.

This card is used to specify the peak voltages of the individual sources used. It consists of three usable fields which identify the segments on which sources will be located, and input the peak voltage of the sources.

On this card (see below) of the input data deck, fields

1 - 5 and 6 - 10 are used to specify the tag number of the source segment and the segment number of a set of segments, respectively. In this case since there is only

one tag number (only one wire) the tag field is left blank and the segment number 1 is specified. That is, the source is located at the base segment of the 32 segment wire monopole. The peak value of the source is unity as specified in Fields 11 - 20.



The preceding paragraphs describe the preparation of a sample input data deck which was prepared to input the problem into the computer. The next set of data

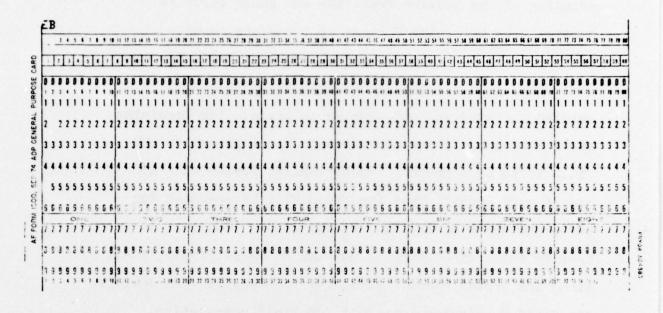
cards to be discussed pertains to requesting output. This set is referred to as Data Request Cards.

### 2.3 Data Request Cards.

A set of commands is required to identify and extract the proper data from the output solution. For example, the program computes induced current, impedance, admittance, field patterns, receive response, etc. The data request cards are used to call out and print all or portions of this data. Specific requests as pertain to the example run in this report will be addressed.

## 2.3.1 Energy Budget.

This card contains only the mnemonic EB. Its purpose is to cause the computations and printing of the total energy input, energy lost in the loads if any and the total energy radiated. It results in the computation of time domain efficiency number. These quantities will be discussed in the output data section of the report.



#### 2.3.2 Radiated Field.

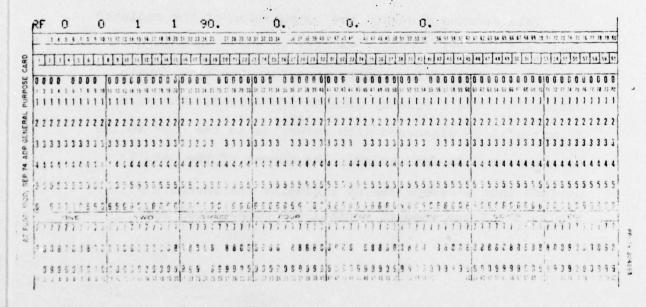
This command requests the computation of the radiated field and outputs appropriate data in the time domain. Further, this card is used to transform the time domain output into the frequency domains if desired. The card format will be discussed with reference to the card in the sample case data deck below. The format of the card is divided into 9 usable fields including the mnemonic RF. Fields 3 - 5 are used to control the computation and

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printing of the Fourier Transform and punch cards if desired. In this case 0 means no transform required.

Fields 6 - 10 are used to control Punching cards for electric field output. In this case the electric field will be printed directly and not punched on cards. The remaining six fields specify the direction in space for which the field is to be computed. Specifically, fields 11 - 15 and 16 - 20 specify that the field will be computed for one 9 and one Ø direction. Fields 21 - 30 and 31 - 40 specify these directions as 90° and 0° respectively, i.e. along the ground plane. Fields 41 - 50 and 51 - 60 specify the 9 and Ø stepping increment for field computation.

In this case both are zero since only one direction is of interest.



2.4 The preceding paragraphs describe the preparation of a data input deck for a specific case. Recall the problem was to determine the radiated field of a monopole antenna on a perfect conducting ground plane fed by a 50 ohm coaxial cable (see Figure 2.1). The sample input data deck was presented to input the problem parameters, i.e. geometry, excitation, loading, etc. and request current computation and far field transmitting response. The following paragraphs will present and discuss the output of the sample case. The radiated and received responses will be presented and compared to experimental results in Section III.

### 2.5 Program Data Output.

The purpose of this portion is to familiarize the reader with the raw output of this program. The output presented is a result of the input problem discussed in paragraph 2.1. Although the output of the program is automatically identified by labels, each portion of the sample output has been identified by circled numbers for easy reference by the reader. The sample output which is discussed below is located at the end of this section.

### 2.5.1 Output Discussion.

The program title Time Domain Antenna Modeling
Program appears at (1) automatically with each output as the
first heading. The comment cards which were presented as
input data follow the heading at (2) and can contain as many
statements as desired. At 3 the first data card is read
and printed. This card contains various time stepping
information as well as any problem symmetry (see input
data card discussion paragraph 2.2.2).

Next the geometry input cards are printed at 4. In this case, a single monopole is modeled by 32 segments with wire radius 0.0032 meters. These outputs identify the wires by tag numbers. The parameters specified by the geometry cards are used to determine the segment centers, lengths, and orientation ( $\alpha$ ,  $\beta$  orientation angles) which are printed in the output at 5. This printout also contains segment interconnection data and tag numbers. The I- I+ notation is used to reference current flow, i.e. current flows from negative to positive. The wire information is summarized at 6.

The table automatically printed out at 7 summarizes the time stepping information used in the solution. It

provides the number of time steps and time stepping interval. If any one of these quantities was not input as data (see first data input card paragraph 2.2.2), it is automatically computed and printed here.

Any options such as symmetry planes, impedance loading, etc. are printed at location (8). This location also identifies the segment for which current will be printed.

The parameters of the excitation are provided at 9. In addition to printing the input excitation data card, the Gaussian characteristic time information is provided. As pointed out in this example, the source has 11.5% of its peak value at t = 0. This value was specified as data input otherwise it would have been automatically computed and printed here.

At location 10, all voltage source information is summarized. It specifies the number of sources, location and peak voltages. If field excitation had been used this section would be replaced by angle of incidence information.

At this point, the program begins the solution for the currents on the segments. The results are printed out as a block of data at 11. The currents are printed from left to right in order of increasing segment number for each time step. In this case there are 160 time steps of = 0.3 ns each. The value of the source strength at each time step is the final entry of each block, labeled excitation.

The results of the Energy Budget request card are printed at 12. The Time Domain Efficiency is defined as the ratio of the total energy radiated to the total energy input and accounts for any energy lost in loads on the structure. If no loads were present in the problem this efficiency would be 100%.

The next block of data 13 in the output is the result of the request for radiated field computations. It provides the electric field (volts/meter) variation for each time step at a specified point in space (theta and phi). It also provides polarization tilt information which is also a useful performance parameter.

The preceding paragraphs have presented a walk through discussion of the use of the time domain program to input a problem and interpret the output. The program was written to emphasize user-ease with a minimum amount

of previous training in numerical techniques or computer understanding. In the next section the results of the sample problem will be analyzed and compared with experimental results.

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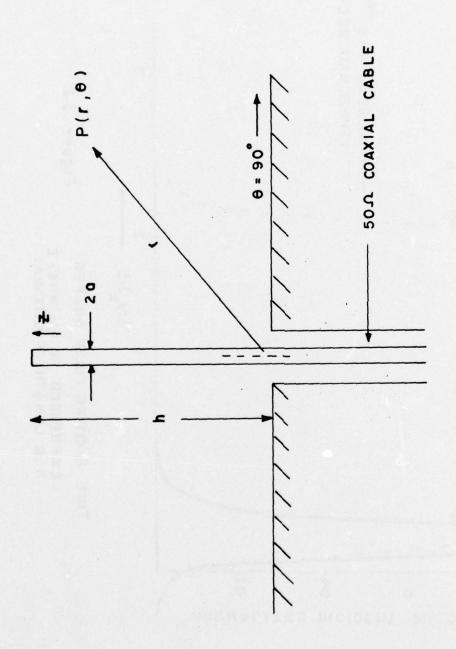
52	0.1565UE-07	0.6660E-12	0	0	132	0.40690E-07	-0.2897E-02 0.	180
53	0.15963E-17	0.3446E-02	0	.0	133	0.41003E-07	-0.4966E-02 0.	180
2.4	0 14374E-07	24555-02			134	0. 41 T1 AF-07		. 80
	10-36/201.0	0.363350			101	10101010		
55	0.16589E-07	0.5311E-32	0.	0.	135	0.41629E-07		180
26	0.16902E-07	0.6508E-02	0	.0	136	0.41942E-07	-0.9497E-02 6,	180
57	0.17215E-07	0.6486E-02		.0	137	0.42255E-07	-0.1052E-01 0.	100
28	0.17528E-07	0.56395-02	.0	.0	138	0,42568E-07	-0.1126E-01 0.	180
20	0.17841E-07	0.47795-02	.0	.0	139	0,42881E-07	-0.1150E-01 0.	180
9	0.18154E-07	0.4409E-02	.0	.0	140	0.43194E-07	-0.1103E-01 0.	180
61	0.18467E-07	0.4510E-02		.0	141	0,43507E-07	-0.9703E-02 0.	180
62	0.18780E-07	0.4816E-02	0	.0	142	0,43820E-07	-0.7599E-02 0.	180
63	0.19093E-07	0.5185E-02		•	143	0.44133E-07	-0.4990E-02 0.	190
	0.19406E-07	0.5734E-U2		.0	**1	0,44446E-07	-0.2273E-02 0.	180
69	0.19719E-07	0.6706E-32	0	.0	145	0,447596-07	0.14065-03 0.	0
99	0.20032E-07	0.8291E-02	.0	.0	146	0.45072E-07	0.1933E-02 0.	0
67	0.20345E-07	0.10546-01	0.	.0	147	0.45385E-07	0.2931E-02 0.	0
89	0.20658E-07	0.1339E-01	0	.0	148	0.45698E-07	0.3128E-02 0.	0
69	0.20971E-07	0.1670E-01	0.	.0	149	0.46011E-07	0.2658E-02 0.	0
76	0.21284E-07	9.2018F-01		.0	150	0,46324E-07	0.1763E-02 0.	0
71	0.21597E-07	8.2340E-U1		.0	151	0.46637E-07	0.7325E-03 0.	0
72	C. 2191.E-17	J. 258 JE-U1	0.	.0	152	0.46950E-07	-0.1571E-03 0.	180
73	3,2223E-07	J.2681E-01	0	.0	153	0,47263E-07	-0.7175E-03 0.	180
74	0.25536F-07	J.2598E-01	0	.0	154	0.47576E-07	-0.8972E-03 0.	1001
75	0.228491-17	J.2319E-01	.0	.0	155	0.47889E-07	-0.7945E-03 0.	180
16	0.231625-7	J.1866E-11	.0	.0	156	0.48202E-07	-0.6232E-03 0.	190
11	0.234756-07	1.13025-11	,		157	0.48515E-07	-0.6453E-03 0.	180
78	0.23788E-17	J.7129E-02	0	.0	158	0,48828E-07	-0.1099E-02 0.	180
19	0.24101E-07	0.1931E-112	0.	.0	159	0.49141E-07	-0.2152E-02 0.	180
00	0,24414E-67	-0.18#9E-#2		180,000	100	0.49454E-07	-0.3899E-02 0.	1.80
POTAL	ENERGY RADIAT	ED = 0.4833E-	12 30	ENERGY RADIATED = 0.45435-12 JOULES/STERADIAN	CTHETAR 90	90,000 DEG., PH	PHI 0. DEG: )	
	OMAIN POWER G							
INE D	DOMAIN DIRECTIVE GAIN =		-n,02 Da	•				
N N N	UNNING TIMEE-1304.330 SEC	330 250						
AG	DATA CARD	0 0	0 0	.0	0.	0.		

SECTION III Comparison of Computed and Measured Results

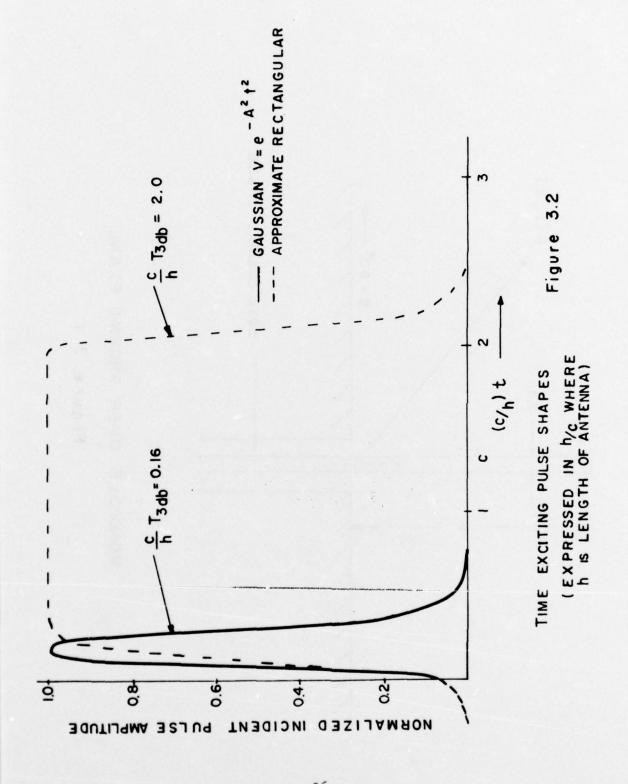
3.0 The purpose of this section is to present and analyze the response of a monopole antenna to short baseband pulses. Both the transmitting and receiving computed responses will be presented and compared to measurements previously published. The computed results were obtained by plotting the output of the TIMDOM program previously discussed.

### 3.1 Transmitting Response.

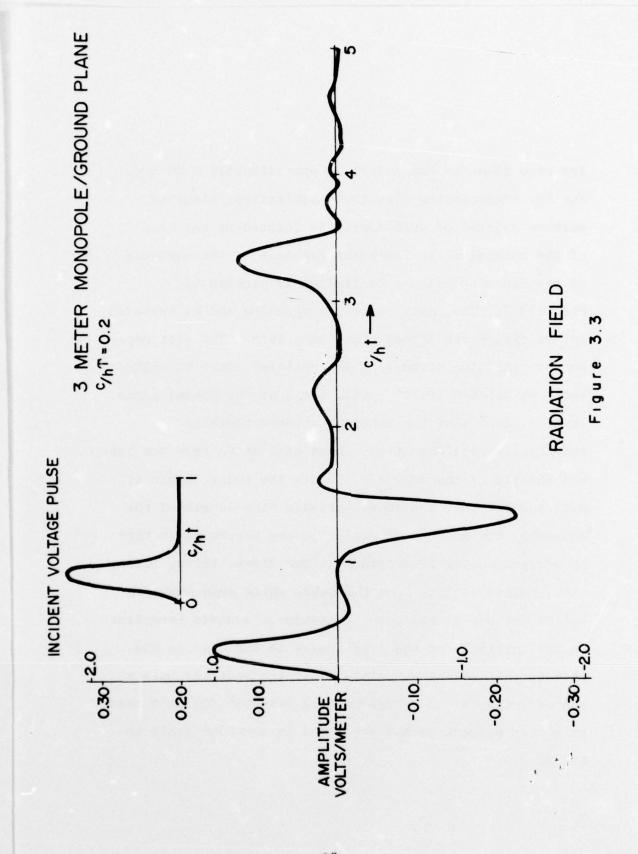
The cylindrical monopole and its zero resistivity ground plane and coaxial feed geometry are shown in Figure 3.1. The specific antenna geometry and excitation used in the computation was scaled in the time domain to the actual measurement geometry.<sup>2</sup> Two dc pulse excitations were used and are shown in Figure 3.2. The excitations are plotted with respect to h/c, the one-way travel time on the antenna where "h" is the monopole length and "c" is the free space velocity of propagation. The narrow excitation is a Gaussian pulse with 3db pulse width of 0.16 h/c (1.6 ns) since h is three meters in the computed case. The broader excitation represents a rectangular pulse with 3db width of 2.0 h/c.



MONOPOLE OVER GROUND PLANE Figure 3.1



The rise time for the pulses is approximately 0.05 h/c. For the transmitting case these excitations simulate voltage sources of unit amplitude located at the base of the monopole. The computed response of the monopole to the Gaussian voltage excitation is plotted in Figure 3.3. The input pulse was rescaled and is included in the figure for direct time comparison. The plot represents the time history of the radiated field in volts/ meter at point P (r, 90°, 0°), i.e., at the ground plane. It is evident that the monopole antenna radiates essentially replicas of the input excitation from the base and the tip of the monopole. Since the pulse length is much shorter than the characteristic time-length of the monopole, the sources of radiation are separated in time by h/c and easily identifiable. The first, third, fifth, etc., pulses radiate from the base, while even-numbered pulses are due to end point radiation. A scale normalized to the amplitude of the first pulse is included on the plot so that relative amplitudes of the radiated pulses can be compared. The experimental results2 for this case have been reproduced and replotted in h/c time scale in Figure 3.4.



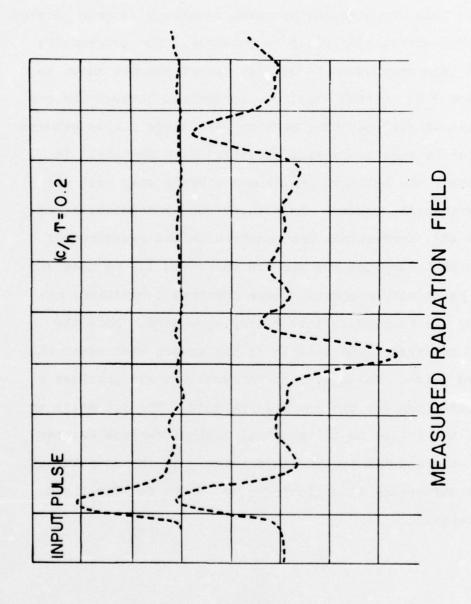
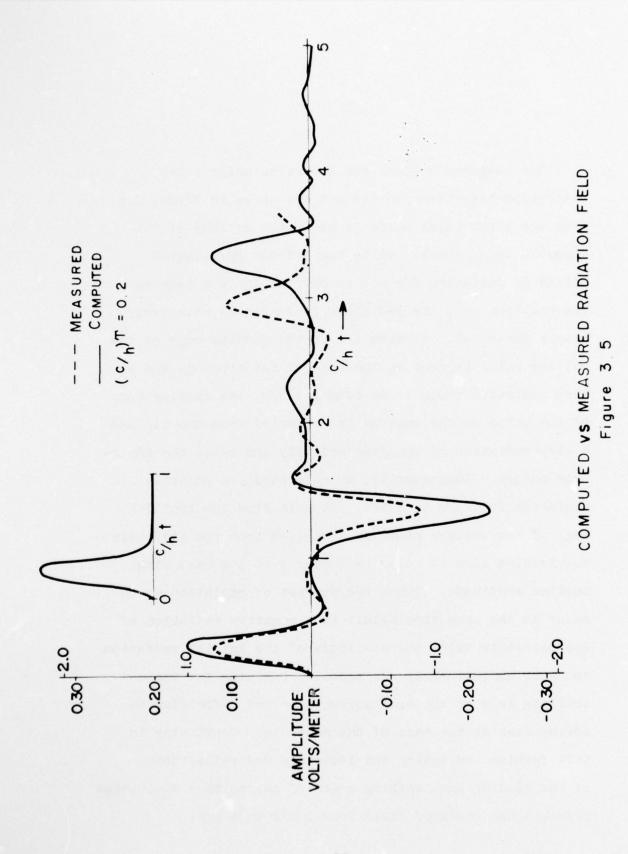
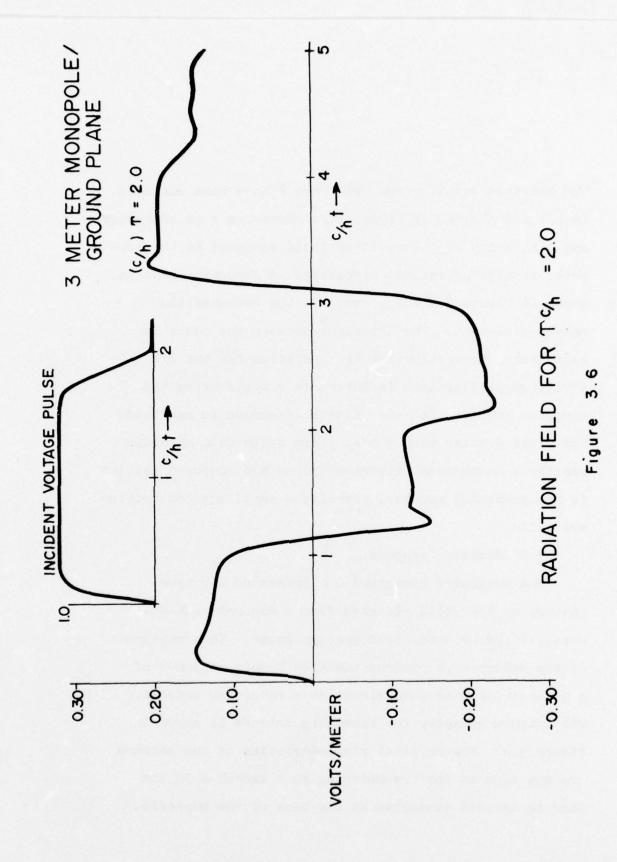


FIGURE 3.4

Since both computed and measured results have been plotted in h/c, direct comparison is possible. The two results have been reproduced in overlay format and are shown in Figure 3.5. Direct amplitude comparison between the two traces is not possible; however, amplitude ratios between pulses in each trace will yield relative results. In general, the relative amplitudes compare very well with experimental results. As pointed out by Schmitt, et al., Page 122, corrections are required in the experimental results to account for the 1/R variation due to base and end point displacement. These required corrections will bring the amplitudes into closer agreement. Note the zero crossovers and details of the pulses even after the third pulse. The agreement is excellent and provides a verification for the computed results. The disparity at time t=3 is due to the physical path difference between the base and tip to the field point. In the computation, this difference is neglected since R+ o for far field calculations.



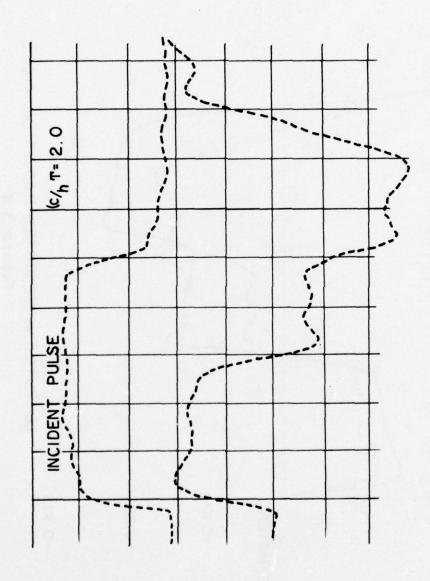
The computed results for the rectangular pulse excitation have been plotted and are shown in Figure 3.6. Note the input pulse which is now twice as long as the monopole time-length. While the effects of isolated points of radiation are not as obvious in this case as the previous one, the radiation field can be relatively simply described. At time t = 0, the leading edge of the voltage pulse emerges at the base of the monopole and a step radiation occurs. At time t = h/c, the leading edge of the pulse on the antenna is reflected from the tip and a step radiation of opposite polarity and twice the amplitude occurs. Consequently, we note negative polarity radiation from h/c to 2 h/c. At this time the trailing edge of the voltage pulse is reflected from the tip while the leading edge is being reflected from the base with smaller amplitude. These two sources of radiation which occur at the same time result in a negative radiation of approximately twice the amplitude of the initial radiation and last approximately h/c seconds, the time for the trailing edge of the excitation pulse and reflection to arrive back at the base of the monopole. Continuing in this fashion and noting the locations and reflections of the leading and trailing edges of the voltage excitation predicts the radiated field from 3 h/c to 5 h/c.



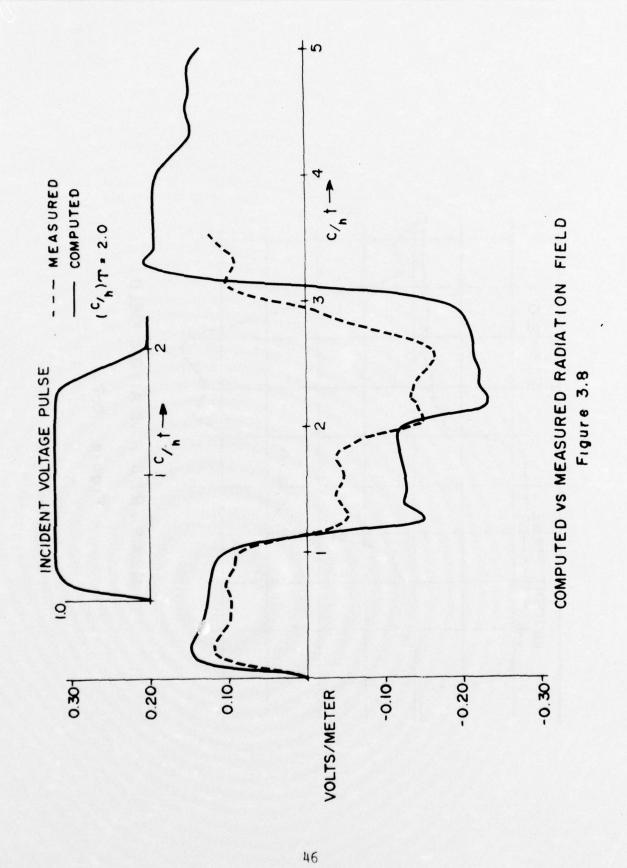
The measured results from Reference 2 have been rescaled in h/c and plotted in Figure 3.7. Note the zero crossover and similarity of the radiated field compared to the computed results previously discussed. A composite plot is shown in Figure 3.8 which overlays the computed and measured results. The agreement between the plots is excellent. Correcting the tip radiation for the 1/R variation as discussed in Reference 3 would bring the computed results into even closer agreement in amplitude for times greater than 3 h/c. Note again that absolute amplitude comparison between measured and computed results is not possible; however, normalized amplitude comparisons are valid.

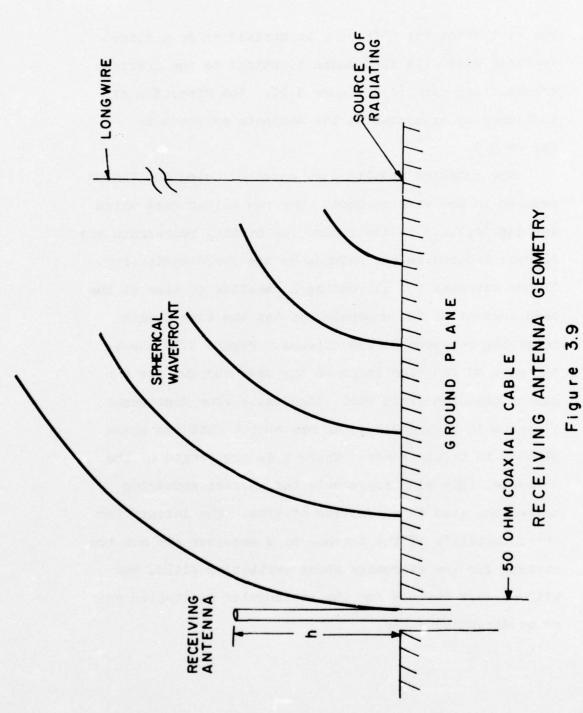
### 3.2 Receive Response.

The preceding paragraph has presented the time history of the field radiated from a monopole antenna when excited by a baseband voltage pulse. This section of the report will present the time domain response of a monopole antenna when viewed as a receiving antenna. The antenna geometry for receiving antenna is shown in Figure 3.9. The physical characteristics of the antenna are the same as the transmitting case except a 50 ohm load is assumed connected at the base of the monopole.



MEASURED RADIATION FIELD Figure 3.7





The excitation for this case is assumed to be a plane incident wave with time shape identical to the previous transmitting case (see Figure 3.2). The direction of incidence is broadside to the monopole as shown in Figure 3.9.

The computed results were obtained using the TIMDOM program in the receive mode. The raw output data which was not included in the report for brevity represents the current induced on the antenna by the field excitation. If one examines the current as a function of time at the base segment of the monopole, he has the time domain receiving response of the antenna. Figure 3.10 shows the plot of 160 time steps of the base current for the narrow Gaussian field excitation whose time dependence is shown in Figure 3.2. The raw output data was again plotted in terms of h/c. Where h is the length of the monopole, this plot represents the current appearing across the load as a function of time. The integrating characteristics of the antenna as a receiver are not too obvious for the extremely short excitation field, but will be more obvious for the rectangular excitation case to be discussed later.

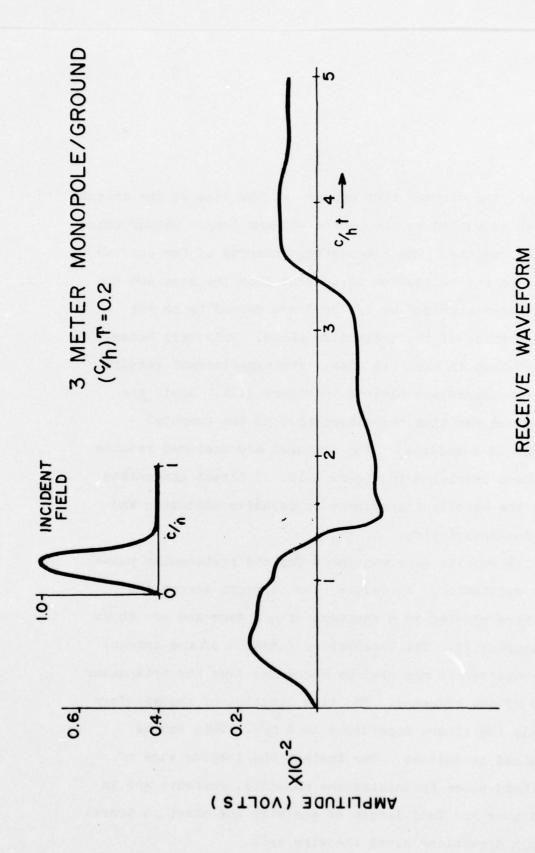
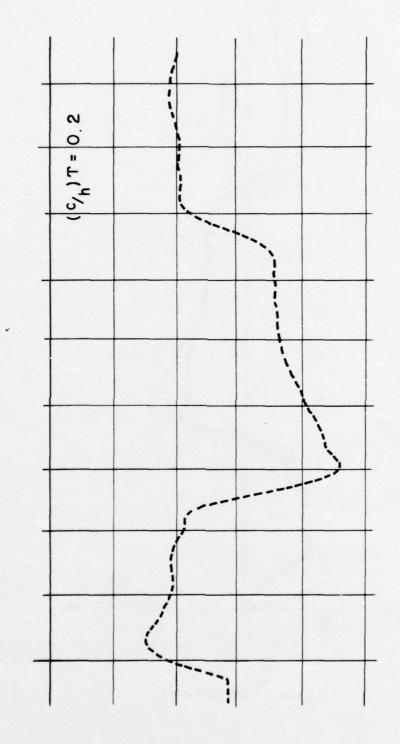


Figure 3.10

49

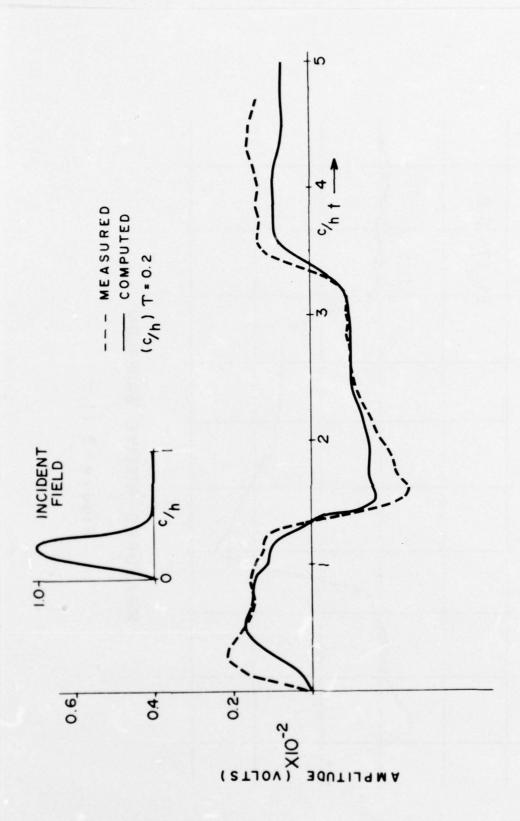
However, the current that appears at the base of the antenna is seen to depend on the entire antenna length rather than isolated points. The alternating polarity of the current is due to the reflection of current from the base and tip and is characterized by h/c or 2 h/c depending on the time duration of the excitation field. This will become more obvious in the next case. The experimental results were reproduced and plotted in Figure 3.11. Again the comparison for time characteristics of the computed results is excellent. The computed and measured results have been overlayed in Figure 3.12. A direct comparison shows the excellent agreement in relative amplitude and time characteristics.

The receive case was rerun for the rectangular pulse field excitation. As before, the currents across the load were plotted as a function of h/c time and are shown in Figure 3.13. The integrating function of the antenna as a receiver is now obvious where one sees the triangular shape of the response. The time duration of the waveform reveals the strong dependence on 2 h/c. This can be explained as follows. The instant the leading edge of the field pulse irradiates the monopole, currents are induced over the full length of the wire and start to travel in both directions along the wire axis.

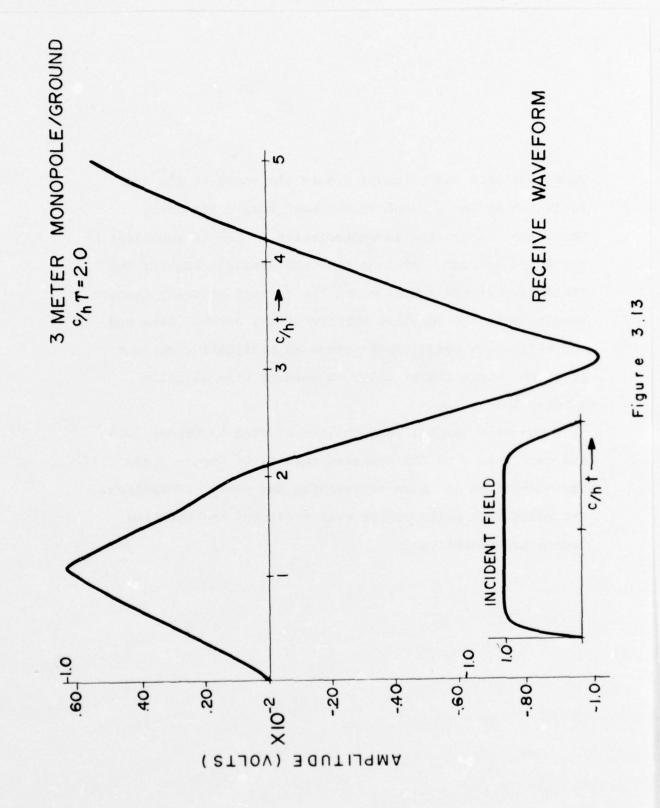


MEASURED RECEIVE WAVEFORM

Figure 3.11

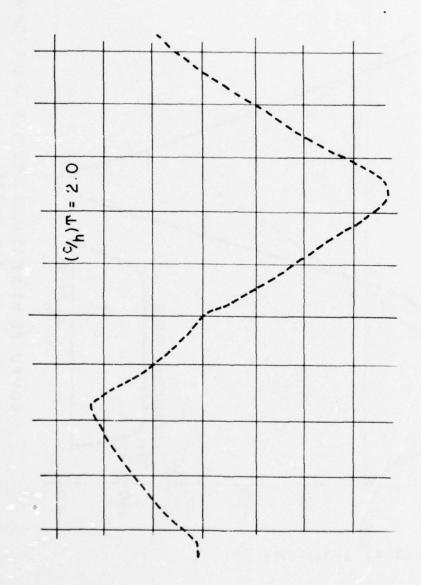


COMPUTED VS MEASURED RECEIVE WAVEFORM Figure 3.12



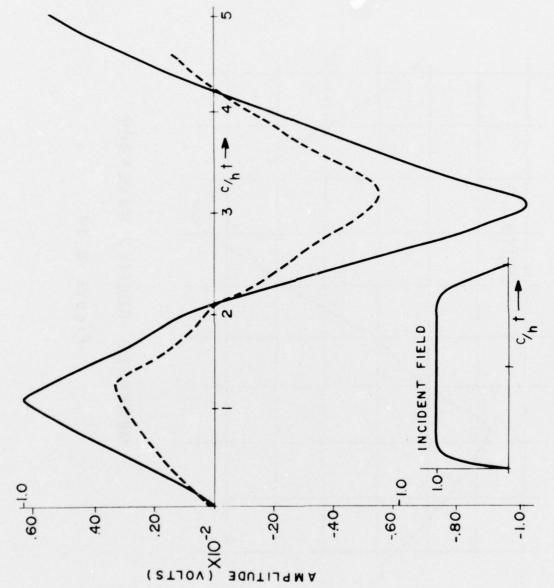
Those currents which travel toward the monopole tip are reflected at the tip and travel back toward the base. Thus, the integrating characteristics of the antenna last for 2 h/c seconds. At that time the trailing edge of the field reaches the monopole and the current polarity changes resulting in the negative portion of the curve. Base and tip reflection coefficients cause an oscillating current plot, the beginning of which is seen at time slightly greater than 4 h/c.

The experimental results were plotted in Figure 3.14 and overlayed with the computed results in Figure 3.15. The comparison is again outstanding and worthy of mention. The relative amplitudes are well predicted and the time traces are exceptional.



MEASURED RECEIVE WAVEFORM

Figure 3,14



CDMPUTED VS MEASURED RECEIVE WAVEFORM Figure 3.15

### SECTION IV Conclusions and Recommendations

A computer routine based upon direct time domain calculations has been presented and discussed. A walkthrough description of inputting the data and interpreting the output has been provided through an example case to familiarize the reader with the ease of user interface. The computer results have been discussed and critically compared with experimentation. The comparison is exceptional and establishes the validity of the program. The program can be used to predict the transmitting and receiving properties of the class of thin wire antennas directly in the time domain. In addition, although not done in this report, the scattered field can also be obtained through the program. The scattered field is the field reradiated from the antenna when irradiated by a field. It results from the radiation caused by the currents induced on the structure due to the field irradiation.

The utility of direct time domain solutions for pulse excitations is receiving more and more consideration in antenna and scatterer analysis. Although this report has not attempted to establish the utility of direct time domain solutions, its importance as an analytical tool

should not be overlooked. It offers considerably more information concerning the broadband frequency performance of an antenna than does c.w. analysis. In addition, the Fourier transform of the time response (an option in the TIMDOM program) can be used to obtain the frequency response of the antennas modeled. If one is concerned with short pulse excitations and time waveform distortions the time domain offers a direct evalution of antenna response. However, if characteristics such as beam width, impedance, admittance, etc., are important, then the frequency domain offers analytical advantages. Nevertheless, it is apparent that direct time domain solutions offer a new look at antenna performance and should be useful to the antenna analyst and designer. A Fortran listing of the TIMDOM program is included in this report as Appendix A. It must be reemphasized that the computer routine was prepared for user-oriented ease of operation and can be used with only minimal theoretical or numerical techniques understanding.

# BEST AVAILABLE COPY

### SECTION V References

- (1) "Time Domain Antenna Study" (Final Report), NRL Contract N00014-73-C-0099
- (2) Harrington, R.F., "Field Computations By Method of Moments", MacMillan, NY, 1968
- (3) Schmitt, H.J., Harrison, C.W., and Williams, Jr. C.S., "Calculated and Experimental Response of Thin Cylindrical Antennas to Pulse Excitation", IEEE Trans. on Antennas & Propagation, Vol. AP-14, March 1966

## APPENDICES

The following appendices are included for those interested in implementation of the program on specific machines.

Appendix A contains a Fortran listing of the TIMDOM program which was written by MB Associates under joint sponsorship by the Navy and Air Force under Contracts N00014-73-C-0099 and F30602-72X0008. The listing contains all subroutines in alphabetical order and all are written in Fortran.

Appendix B contains a listing of all machine independent diagnostics which appear in the program to aid the user.

Machine dependent subroutines employed in the program which are specific to the Honeywell/GE635 computer, are identified and listed in Appendix C.

#### APPENDIX A

```
C
       TIME DOMAIN ANTENNA MODELING PROGRAM
       COMMON /DATA/ N,NP,X(200),Y(200),Z(200),SI(200),BI(200),ALP(200),
                                                                                               5
            BET(200), ICON1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ
       COMMON /SCOMP/ SX(200),SY(200),SZ(200)
COMMON /CONST/ CDT,VEL,DT,NTSTEP
COMMON /LOAD/ RES(200),ELD(200),CAP(200),ILOAD
                                                                                         TH
                                                                                         TW
                                                                                         TH
       COMMON /IOFLG/ NCFMX, NCQMX, IOC, IOCQ, NTMAX, NBOUT, JP1, JP2
                                                                                         TW
       COMMON /MATPAR/ NBLUKS, NPBLK, NLAST, INX
       COMMON /ARRAY/ CQ(6400)
COMMON /ESURC/ ESURC(1024), IFST, NTRAN, MTRAN, NTNX, DFRO, ENIN, ENHO, I
                                                                                         TH
                                                                                              10
      1FEN
                                                                                              11
       COMMON /ASORC/ EMAG(10), ISRC(10), NSRC
COMMON /CMAT/ CURF(1600), IP(200), IX(200)
                                                                                         TW
                                                                                              12
                                                                                         TW
                                                                                              13
       DIMENSION COM(13,5), ITST(8)
                                                                                         TW
                                                                                              14
       INTEGER HX, HY, HZ
                                                                                         TW
                                                                                              15
       DATA
               HX, HY, HZ/1HX, 1HY, 1HZ/
                                                                                         TA
               ITST/2HCM, 2HCE, 2HAT, 2HRF, 2HPC, 2HNX, 2HEN, 2HEB/
       DATA
                                                                                         TW
                                                                                              17
       RTM1=0.
                                                                                         TW
                                                                                              18
       RTM2=0.
                                                                                              19
       RTM3=0.
                                                                                         TW
                                                                                              20
       CALL SECOND (RTM1)
                                                                                         TW
                                                                                              21
       NCF MX=17600
                                                                                         TW
                                                                                              25
       NCQMX=6400
                                                                                         TW
                                                                                              23
       IRESRV=1600
                                                                                         TW
       VEL=2,998E+8
                                                                                         TW
                                                                                              25
       PI=3.1415926
                                                                                         TW
                                                                                              50
       TA=PI/180.
                                                                                         TW
                                                                                              27
       TD=180./PI
                                                                                         TW
                                                                                              85
       NTHX=1024
                                                                                         TW
                                                                                              29
       PRINT 57
                                                                                         TW
                                                                                              30
       CALL SECOND (RTM2)
                                                                                         TW
                                                                                              31
                                                                                         TW
       IFEN=0
                                                                                              32
       IFST=0
                                                                                         TW
                                                                                              33
                                                                                         TH
       JCUM=0
                                                                                              34
                                                                                         TH
                                                                                              35
C
       READ AND PRINT COMMENT CARDS
                                                                                         TW
                                                                                              36
                                                                                         TW
                                                                                              37
       JCOM=JCOM+1
                                                                                         TA
                                                                                         TW
                                                                                              39
       IF (JCOM.GT.5) JCOM=5
       HEAD 58, INA, (COM(I, JCOM), I=1,13)
                                                                                         TW
                                                                                              40
       PRINT 59, (COM(I, JCOM), 1=1,13)
                                                                                         TH
                                                                                              41
       IF (INA.EO.ITST(1)) GO TO 2
                                                                                         TW
                                                                                              42
       IF (INA.EQ. ITST(2)) GO TO 3
                                                                                         TA
                                                                                              43
       PRINT 77
                                                                                         TW
                                                                                              44
       STOP
                                                                                         TH
                                                                                              45
                                                                                         TH
                                                                                              46
C
       HEAD AND PRINT FIRST DATA CARD
                                                                                         TW
                                                                                              47
C
                                                                                         TW
                                                                                              48
       READ 63, DT, TMAX, NTSTEP, IPX, IPY, IPZ, ILMAD, JP1, JP2
                                                                                         Tw
                                                                                              49
       PRINT 64, DT, TMAX, NTSTEP, IPX, IPY, IPZ, ILUAD, JP1, JP2
                                                                                         TW
                                                                                              50
       CALL IFEH (IPX)
                                                                                         TW
                                                                                              51
       CALL IFEH (IPY)
                                                                                         TW
       CALL IFEH (IPZ)
                                                                                         TH
                                                                                             53
                                                                                         TW
C
                                                                                              54
       CALL DATAGN TO SET UP STRUCTUPE GEOMETRY
                                                                                              55
C
                                                                                         TM
C
```

```
CALL
              DATAGN
                                                                               TW
                                                                                    57
      NP=N
                                                                               TH
                                                                                    58
      PRINT 60
                                                                               TH
                                                                                    59
      PRINT 61
                                                                               TW
                                                                                    60
      SSUM=0.
                                                                               TH
                                                                                    61
      SMAX=0.
                                                                               TW
                                                                                    62
      DO 4 1=1.N
                                                                               TW
                                                                                    63
      AD=ALP(I) +TD
                                                                               TH
                                                                                    64
      BO=BET(I) . TO
                                                                               TW
                                                                                    65
      SII=SI(I)
                                                                               TW
                                                                                    66
                  I, x(1), y(1), Z(1), SII, AD, BD, BI(1), ICON1(1), I, ICON2(1),
      PRINT 62.
                                                                               TW
                                                                                    67
     1 ITAG(I)
                                                                               TW
                                                                                    68
      SSUM=SSUM+SII
                                                                               TM
                                                                                    69
      IF (SII.GT.SMAX) SMAX=SII
                                                                               TW
                                                                                    70
4
      CONTINUE
                                                                               TA
                                                                                    71
      PRINT 65, N. SSUM, SHAX
                                                                               TH
                                                                                    72
C
                                                                               TH
                                                                                    73
      DETERMINE TIME STEPPING INTERVAL, DT
                                                                               Tw
                                                                                   74
C
                                                                               TW
                                                                                   75
      IF (DT.GT.1.E-25) GO TO 5
                                                                               TH
                                                                                    76
      DI=SMAX/VEL
                                                                               TW
                                                                                    77
      SII=10. **(INT(ALOG10(DT))-3)
                                                                               TW
                                                                                    78
      DT=AINT(DT/S11+.999)+SII
                                                                               TH
                                                                                    79
5
      NTMAX=INT(TMAX/DT)+1
                                                                               TW
                                                                                    80
      IF (NTMAX, GT. 1) GO TO 6
                                                                               TW
                                                                                    81
      IF (NISTEP.EQ.O) GO TO 39
                                                                               TW
                                                                                    82
      GO TO 8
                                                                               TW
                                                                                    83
      IF (NTSTEP.GT.O) GO TO 7
                                                                               TW
                                                                                    84
      NTSTEP=NTMAX
                                                                               TW
                                                                                    85
      GO TO 8
                                                                               TW
                                                                                    86
      IF (NTMAX.LT.NTSTEP) NTSTEP=NTMAX
                                                                               TW
                                                                                    67
      TMAX=DT*FLUAT(NTSTEP-1)
                                                                               TW
                                                                                    88
      NTRAN=NTSTEP
                                                                               TW
                                                                                    89
      IF (NTRAN. GT. NTNX) NTRAN-NTNX
                                                                               TW
                                                                                    90
      COT=OT+VEL
                                                                                   91
                                                                               TW
      PRINT 73, DT, TMAX, NTSTEP
                                                                               TW
                                                                                    92
      IF (JP1.LT.1) GO TO 9
                                                                                   93
                                                                               TW
      IF (JP2.LT.JP1) JP2=JP1
                                                                               TW
                                                                                    94
      60 10 10
                                                                               TW
                                                                                    95
9
      JP1=1
                                                                               TW
                                                                                   96
      JP2=N
                                                                               TW
                                                                                   97
      PRINT 66
10
                                                                               TH
                                                                                   98
      IF (IPX) 11,13,12
                                                                                   99
      PRINT 67. HX
11
                                                                               TW 100
      GO 10 13
                                                                               TW 101
      PRINT 68, HX
12
                                                                               TH 102
      IF (IPY) 14,16,15
13
                                                                               TW 103
      PRINT 67, HY
14
                                                                               TW 104
      GO TO 16
                                                                               TH 105
15
      PRINT 68, HY
                                                                               TH 106
      IF (1PZ) 17,19,18
                                                                               TW 107
16
17
      PRINT 67, HZ
                                                                               TW 108
      60 10 19
                                                                               TW 109
18
      PRINT 68, HZ
                                                                               Tm 110
      IF (ILOAD.NE.O) PRINT 69
19
                                                                               TW 111
      IF (ILUAD. EQ. 0) PRINT 70
                                                                               TH 112
      PRINT 71, JP1, JP2
                                                                               TW 113
      IF (ILUAD.EQ.O) GO TO 24
                                                                               TW 114
C
                                                                               Ta 115
      READ IMPEDANCE LOADING CARDS
                                                                               TW 116
```

```
C
                                                                               TH 117
       PRINT 74
                                                                               TH 118
      00 20 I=1.N
                                                                               Th 119
       RES(1)=0.
                                                                               TH 120
                                                                               IM 151
      ELD(1)=0.
      CAP(1)=0.
50
                                                                               IM 155
      READ 75.
                 J. ITG, II, RESI, ELDI, CAPI
                                                                               Tm 123
21
       I=ISEGNO(ITG, II)
                                                                               T# 124
       IF (ABS(CAPI), LT. 1, E-20) GO TO 22
                                                                               TH 125
      PRINT 76. ITG, II, I, HESI, ELDI, CAPI
                                                                               TW 126
      GO TO 23
                                                                               TH 127
22
       PRINT 76,
                 ITG, II, I, RESI, ELDI
                                                                               T# 128
      RES(1)=RESI
23
                                                                               TW 129
       ELD(1) = ELDI
                                                                               Tm 130
      CAP(I)=CAPI
                                                                               TW 131
       IF (J.NE.0) GO TO 21
                                                                               T# 132
24
      CALL CONSET
                                                                               TH 133
C
                                                                               TW 134
                                                                               TW 135
C
      CALL ESET (ENTRY POINT OF EINCF) TO READ EXCITATION DATA CARDS
                                                                               Tw 136
C
      CALL ESET (RESI)
                                                                               TH 137
      CALL FBLOCK (NBLOKS, NPBLK, NLAST, IRESRV, N, INX)
                                                                               TW 138
      CALL COFS (CURF, CURF, N)
                                                                               TW 139
                                                                               TH 140
       CALL FACIO (CURF, CURF, N, IX, IP)
       CALL SECOND (RTM3)
                                                                               TH 141
       RTM=RTM3-RTM2
                                                                               TW 142
      PRINT 46, RTM
                                                                               TW 143
C
                                                                               TH 144
C
      SOLVE FOR STRUCTURE CURRENTS
                                                                               Tm 145
                                                                               TH 146
C
      CALL TSUL (CURF, 1X, IP, N)
                                                                               T# 147
      CALL SECUND (HTM)
                                                                               Tm 148
      RTH=RTH-RTH3
                                                                               TH 149
      PRINT 47, RTM
READ 40, INA, ITM1, ITM2, ITM3, ITM4, TM1, TM2, TM3, TM4
                                                                               Tm 150
25
                                                                               Tw 151
      CALL SECOND (RTM)
                                                                               TW 152
      RTH=RTH-RTM1
                                                                               TW 153
      PRINT 48, RTM
                                                                               Tw 154
      PRINT 41, INA, ITM1, ITM2, ITM3, ITM4, TM1, TM2, TM3, TM4
                                                                               TH 155
                                                                               TW 156
      IF (INA, EQ, 1157(3)) GO TO 26
       IF (INA.EQ.ITST(4)) GO TO 27
                                                                               TW 157
       IF (INA.EQ. ITST(5)) GO TO 28
                                                                               TW 158
       IF (INA, EQ. ITST (6)) GO TO 1
                                                                               T# 159
      IF (INA.EQ. ITST(7)) STOP
                                                                               TH 160
       IF (INA.EQ. 1757(8)) GO TO 29
                                                                               TH 161
      PRINT 42
                                                                               TW 162
      STOP
                                                                               TW 163
C
                                                                               TH 164
      COMPUTE ANTENNA INPUT ADMITTANCE
C
                                                                               Th 165
                                                                               T# 166
C
      I=1SEGNU([TM1.ITM2)
                                                                               TW 167
26
      CALL ANTRAN (I, TM1, ITM3)
                                                                               TH 168
      GO TU 25
                                                                               Tw 169
                                                                               TW 170
C
      COMPUTE RADIATED FIELDS
C
                                                                               TH 171
                                                                               TW 172
C
      CALL REPAT (ITM1, ITM2, ITM3, ITM4, TM1, TM2, TM3, TM4)
                                                                               Tm 173
27
                                                                               TH 174
      GO TU 25
C
                                                                               TH 175
                                                                               T# 176
      PUNCH CURRENTS
```

28	C		Tw 177
CALL CCET (I, CUPF, NTRAN) PUNCH 43, CCUM(J, I), 21, 13) PUNCH 44, NTSTEP, I, ITHI, ITM2 PUNCH 44, NTSTEP, I, ITHI, ITM2 PUNCH 45, CCUMF(J), J=1, NTSTEP)  GO TO 25  C C COMPUTE ENERGY BUDGET  C C C COMPUTE ENERGY BUDGET  TI 188 ENINSO, IN 189 IF (NSRC, LT, 1) GO TO 33 IF (187 IF (NSRC, LT, 1) GO TO 32 IF (187 IF (NSRC, LT, 1) GO TO 32 IF (187 IF (NSRC, LT, 1) GO TO 32 IF (197 IFENSI PRINT 50 OO 31 I=1, NSRC OO 31 I=1, NSRC IN 199 OO 31 I=1, NSRC IN 199 OO 30 J=1, NTRAN RESITESOMC(J) IF (RESI, LT, 1, LE-20) GO TO 30 SUMSO, OO 30 J=1, NTRAN RESITESOMC(J) IF (RESI, LT, 1, LE-20) GO TO 30 SUMSSUM-SUM-SESIECURF(J) SUMSSUM-SUM-SESIECURF(J) IF (188) IF (198) IF (22) IF (198) IF (198) IF (21) IF (198) IF (22) IF (198) IF (23) IF (24) IF (26) IF (28)	28	1=ISEGNO(ITM1,ITM2)	
PUNCH 43, (COMCJ.1), J=1,13) PUNCH 43, (COMF(J), J=1,NTSTEP) PUNCH 43, (CURF(J), J=1,NTSTEP) PUNCH 43, (CURF(J), J=1,NTSTEP)  C C COMPUTE ENERGY BUDGET  C C PRINT 49 ITH200 ITH200 ITH200 ITH200 ITH300 ENLS00, ITH300 ENLS00, ITH300 IT			
PUNCH 49, (CURF(J),J=1,NT3TEP)			
PUNCH 49, (CURF(J),J=1,NTSTEP)			
GO TO 25  C COMPUTE ENERGY BUDGET  C COMPUTE ENERGY BUDGET  C COMPUTE ENERGY BUDGET  TH 1836  C COMPUTE ON THE STATE OF TH			
C COMPUTE ENERGY BUOGET  C PRINT 49 ITM280 ENINEO. ENLSSO. ENLSSO. IF (ISSEC,LT,1) GO TO 33 IF (IFST,NE,0) GO TO 32 IF (IFST,NE,0) GO TO 30 IF (IFST,NE,0) GO TO 34 IF (IFST,NE,0) GO TO 34 IF (ITM2,0) GO TO 35 IF (ITM2,0) GO TO 36 IF (ITM2,0			
The 180	•		
The 180	č	COMPUTE ENERGY BUDGET	
PRINT 49	č	Com die etemat booder	
ITM200 ENINGO, TH 189 ENINGO, TH 189 ENINGO, TH 189 ENINGO, TH 189 ENINGO, TH 190 IF (NSRC,LT,1) GO TO 33 IF (1FST,RE,0) GO TO 32 IF (1SCURF,NTRAN) SUMGO, TH 190 OD 30 JEI,NTRAN RESIESORC(J) IF (RESILITI,E=20) GO TO 30 SUMSSUMH=RESI*CURF(J) TH 200 SUMSSUM+RESI*CURF(J) TH 203 SUMSSUM+RESI*CURF(J) TH 205 SUMSSUM+RESI*CURF(J) TH 205 IF (1FGS,LT,LE,20) GO TO 30 SUMSSUM+RESI*CURF(J) TH 205 SUMSSUM+RESI*CURF(J) TH 205 SUMSSUM+RESI*CURF(J) TH 205 SUMSSUM+RESI*CURF(J) TH 205 SUMSSUM+RESI*CURF(J) TH 206 SUMSSUM+RESI*CURF(J) TH 207 TH 208 SUMSSUM+RESI*CURF(J) TH 207 TH 208 SUMSSUM+RESI*CURF(J) TH 208 SUMSSUM+RESI*CURF(J) TH 207 TH 210 OD 35 JEI,NTRAN TH 211 FRINT 52 TH 214 SUMSSUM+DH*ES(T),NTRAN) TH 215 SUMSSUM+DH*ES(T)	20	PRINT 49	
ENINSO, ENLSO, ENLSO, IT 190 IF (NSRC,LT,1) GO TO 33 IF (195T,ME,0) GO TO 32 IF (195T,ME,0) GO TO 31 IS=ISRC(I) VLT=EMAG([1)*SI(IS) CALL CGET (IS,CURF,NTRAN) TA 199 SUMSO, DO 30 JE1,NTRAN HESI=ESORC(J) IF (RESI,LT,1,E=20) GO TO 30 RESI=ESORC(J) IF (RESI,LT,1,E=20) GO TO 30 SUMSSUM+RESI*CURF(J) TA 200 SUMSSUM+RESI*CURF(J) TA 201 SUMSSUM+RESI*CURF(J) IF (RESI,LT,1,E=20) GO TO 30 IF 202 SUMSSUM+RESI*CURF(J) TA 203 IF (1LOAD,EQ,0) GO TO 37 OO 35 JE1,NTRAN IF (RES(I),LT,1,E=20) GO TO 36 IF (11T2,E0,1) GO TO 34 IF (11T2,E0,1) GO TO 34 IF (212 IF (11T2,E0,1) GO TO 34 IF 213 SUMSO, DO 35 JE1,NTRAN TA 215 SUMSOU*CURF(J)*CURF(J) SUM=SUM+DT**RES(I) PRINT 52 IF (1T2,E0,1) GO TO 34 IF 215 SUMSSUM+DT**RES(I) PRINT 53, I,RE\$(I),SUM IF 220 IF (ENRO,LT,1,E=20) IFENEO IF (			
ENLS=0.  IF (NSRC,LT.1) GO TO 33  IF (1FST,NE,O) GO TO 32  IF (1PST,NE,O) GO TO 32  IF (1PST,NE,O) GO TO 31  IF (1PST,NE,O) TH 193  SUM=0.  CALL COET (1S,CURF,NTRAN)  SUM=0.  OD 30 J=1,NTRAN  REST=ESORC(J)  IF (REST,LT,1,E=20) GO TO 30  SUM=SUM+DFSVLT  PRINT 51, I,1S,SUM  CONTINUE  SUM=SUM+DFSVLT  PRINT 54, I,1S,SUM  IF (1PST,NE,O)  SUM=SUM+DFSVLT  PRINT 56  IF (1DAD,EQ,O) GO TO 37  OD 36 1=1,N  IF (1ESST),LT,1,E=20) GO TO 36  IF (21PST,NE,O)  OD 35 J=1,NTRAN)  TH 203  PRINT 52  IF (1TH2,EQ,1) GO TO 34  PRINT 52  IF (1TH2,EQ,1) GO TO 34  PRINT 52  IF (1TM2,EQ,1) GO TO 34  PRINT 55  SUM=SUM+DF*NES(I)  PRINT 55, I,RES(I),SUM  ENLS=SUM+SUMFDF*NES(I)  PRINT 53, I,RES(I),SUM  ENLS=SUM-SUMFDF*NES(I)  PRINT 53, I,RES(I),SUM  ENLS=SUM-SUMFDF*NES(I)  PRINT 53, EXIN,ENLS,ENRO  IF (ENN-DCT,1,E=20) IFENEO  IF (220  PRINT 55, TM1  IF 235  TH 235  TH 235  TH 235  TH 235  TH 235  TH 235			
IF (NSAC, LT, 1) & Q TO 33			
IF (IFST.NE.0) GO TO 32  IF (IFST.NE.0) GO TO 34  IF (ITM.EGG.1).T.I.E.20) GO TO 36  IF (ITM.EGG.1).T.I.E.20) GO TO 37  IF (ITM.EGG.1).T.I.E.20) GO TO 38  IF (ITM.EGG.1).T.I.E.20) IF EMBO  IF (EMBOLIN.EMLS  IF (ITM.EGG.1).T.I.E.20) IF EMBO  IF (ITM.EGG.1).T.I.			
IFEN=1			
PRINT 50			
DO 31 1=1,NSRC			
IS=ISRC(I)			
VLT=EMG([])*S[(1S) CALL CGET (IS,CURF,NTRAN) SUM=0, DO 30 J=1,NTRAN RESI=ESOR(J) IF (RESI,LT,1,E=20) GO TO 30 SUM=SUM+RESI=CURF(J) TM 201 IF (RESI,LT,1,E=20) GO TO 30 SUM=SUM+RESI=CURF(J) TM 202 SUM=SUM+RESI=CURF(J) TM 203 SUM=SUM+RESI=CURF(J) TM 204 SUM=SUM+RESI=CURF(J) TM 205 PRINT 51 I,IS,SUM TM 205 PRINT 55 TM 207 GO TO 33 TM 208 33 IF (1L0AD,EQ,0) GO TO 37 TM 210 DO 36 I=1,N IF (RES(I),LT,1,E=20) GO TO 36 TM 212 IF (ITM2,EQ,1) GO TO 34 TM 213 PRINT 52 TM 214 ITM2=1 TM 215 SUM=SUM+CURF(J)*CURF(J) SUM=SUM+CURF(J)*CURF(J) TM 216 SUM=SUM+CURF(J)*CURF(J) TM 217 SUM=SUM+CURF(J)*CURF(J) TM 218 TM 220 PRINT 53, I,REŠ(I),SUM TM 219 SUM=SUM+CURF(J)*CURF(J) TM 220 PRINT 54, ENIN,ENLS,ENRO TM 223 TM 224 PRINT 55, I,REŠ(I),SUM TM 225 TM (EMRO,LT,1,E=20) GO TO 38 TM 226 TM (EMRO,LT,1,E=20) FEN=0 TM 226 TM (EMRO,LT,1,E=20) FEN=0 TM 227 TEN=0 TM 228 TM 1=100.*ENRO/ENIN TM 233 TM 1= 233 TM 1= 100.*ENRO/ENIN PRINT 55, TM 1 TM 233 TM 234 CC TM 235 TM 235 TM 237 CC TM 237 TM 233 TM 234 TM 235			
CALL CGET (IS,CURF,NTRAN)  SUM=0.  DO 30 J=1,NTRAN  RESI=ESORC(J)  IF (RESIL,1.1.=20) GO TO 30  SUM=SUM+RESI+CURF(J)  TO 201  TO 201  TO 201  TO 202  SUM=SUM+PT*VLT  PRINT SI, I,IS,SUM  TO 205  SUM=SUM+SUM-SUM  TO 206  TO 33  PRINT S6  TO 207  TO 34  PRINT S6  TO 207  TO 35  PRINT S6  TO 207  TO 36  TO 207  TO 36  TO 207  TO 36  TO 207  TO 36  TO 207  TO 37  TO 207  TO 30 TO 34  PRINT S2  IF (ILOAD_CEQ.0) GO TO 37  TO 36  TO 211  IF (RES(I)_LT,I,E-20) GO TO 36  TO 211  TO 211  TO 211  TO 211  TO 212  TO 213  TO 214  TO 215  TO 216  TO 217  TO 217  TO 217  TO 218  TO 219  TO 229  TO 2			
SUMBO, DO 30 J=1,NTRAN RESI=ESCRC(J) IF (RESI,LI,1.=20) GO TO 30 SUMBSUMHERSI*CURF(J)  30 CONTINUE SUMSUMHERSI*CURF(J)  31 ENIMEDIN+SUM GO TO 33 IF (ILCAD,EQ,O) GO TO 37 DO 36 J=1,N IF (RES(I),LI,1.E=20) GO TO 36 IF (ITM2.EQ,I) GO TO 37 IF (RES(I),LI,1.E=20) GO TO 36 IF (ITM2.EQ,I) GO TO 34 PRINT 52 IF (ITM2.EQ,I) GO TO 34 PRINT 52 IF (ITM2.EQ,I) GO TO 34 PRINT 52 IF (SUMBSUMHERSI) IF (SUMBSUMHERSIC) IF (SUMBSUMHERS			
DO 30 J=1,NTRAN RESI=ESORC(J) IF (RESI,LT.1,E=20) GO TO 30 SUM=SUM+RESI=CURF(J)  30 CONTINUE SUM=SUM+OT*VLT PRINT 51, I,IS,SUM  1 ENIN_ENIN+SUM GO TO 33 TH 203 TH			
RESI=ESONC(J)  IF (RESI,LI,1.E=20) GO TO 30  SUM=SUM+RESI=CURF(J)  TH 203  SUM=SUM+PRESI=CURF(J)  TH 204  SUM=SUM+PRESI=CURF(J)  TH 205  PRINT 51, I,IS,SUM  TH 206  TH 207  GO TO 35  IF (SUM=SUM+SUM)  TH 207  TH 208  TH 209  TH 209  TH 209  TH 209  TH 209  TH 210  DO 36 I=1,N  TH 211  IF (RES(1),LI,1.E=20) GO TO 36  IF (ITM2,EG,1) GO TO 34  TH 213  PRINT 52  TH 214  TH 215  TH 215  TH 216  SUM=SUM+CURF(J)*CURF(J)  SUM=SUM+CURF(J)*CURF(J)  TH 216  PRINT 53, I,RES(I),SUM  TH 227  TH 228  TH 229  PRINT 54, ENIN,ENLS,ENRD  IF (ENRO,LI,1.E=20) GO TO 38  TH 225  TH 226  GO TO 25  TH 227  TH 228  TH 229  TH 220  TH 225  TH 221  TH 225  TH 225  TH 226  TH 227  TH 228  TH 229  TH 229  TH 220  TH 225  TH 221  TH 225  TH 226  TH 227  TH 228  TH 229  TH 220  TH 225  TH 221  TH 225  TH 226  TH 227  TH 228  TH 229  TH 220  TH 225  TH 221  TH 225  TH 226  TH 227  TH 228  TH 229  TH 220  TH 225  TH 221  TH 225  TH 226  TH 227  TH 228  TH 229  TH 220  TH 225  TH 221  TH 225  TH 226  TH 227  TH 228  TH 231  TH 233  TH 234  TH 233  TH 234  TH 233  TH 234			
IF (RESILT, 1.E-20) GO TO 30  SUM=SUM+RESICURF(J)  TH 203  SUM=SUM+PESICURF(J)  TH 205  PRINT 51, I, IS, SUM  IN 205  PRINT 51, I, IS, SUM  IN 206  31 ENINEENIN+SUM  GO TO 33  PRINT 56  31 F(ILO40, E0, 0) GO TO 37  TH 208  33 IF (ILO40, E0, 0) GO TO 36  IF (ITM2, EG, 1) GO TO 34  PRINT 52  IF (ITM2, EG, 1) GO TO 34  PRINT 52  TH 213  CALL CGET (I, CUHF, NTHAN)  SUM=50.  DO 35 J=1, NTHAN  TH 216  SUM=SUM+DT=RES(I)  PRINT 53, I, RES(I), SUM  ENLS=ENLS+SUM  TH 229  SUM=SUM+DT=RES(I)  PRINT 53, I, RES(I), SUM  ENLS=ENLS+SUM  TH 223  TH 224  TH 225  TH 225  TH 226  GO TO 25  TH 227  TH 228  TH 227  TH 228  TH 227  TH 227  TH 228  TH 227  TH 227  TH 228  TH 229  TH 229  TH 220  TH 220  TH 227  TH 228  TH 227  TH 228  TH 229  TH 229  TH 220  TH 220  TH 221  TH 223  TH 224  TH 231  TH 232  TH 233  TH 234  TH 234  TH 234			
SUM=SUM+RESI+CURF(J)  TH 203  CONTINUE  SUM=SUM+DT+VLT  PRINT 51, I,IS,SUM  ENIN=ENIN+SUM  GO TO 33  PRINT 56  TH 209  32 PRINT 56  TH 209  33 IF (ILOAD, EQ.O.) GO TO 37  DO 36 I=1,N  IF (RES(I),LT.1.E-20) GO TO 36  IF (ITH2,EU.I) GO TO 34  PRINT 52  TH 213  CALL CGET (I,CURF,NTRAN)  TH 215  SUM=SUM+CURF(J)*CURF(J)  SUM=SUM+CURF(J)*CURF(J)  PRINT 53, I,RES(I),SUM  ENLS=ENLS+SUM  CONTINUE  TH 221  TH 222  PRINT 53, I,RES(I),SUM  ENLS=ENLS+SUM  TH 223  TH 224  PRINT 54, ENIN,ENLS,ENRO  IF (ENRO,LT.1.E-20) IFENSO  IF (ENRO,LT.1.E-20) IFENSO  IF (ENRO,LT.1.E-20) IFENSO  TH 225  TH 226  TH 227  TH 227  TH 228  TH 229  TH 229  TH 229  TH 220  TH 220  TH 221  TH 222  TH 223  TH 224  PRINT 57, TM 224  PRINT 58, ENIN,ENLS,ENRO  TH 225  TH 226  TH 227  TH 228  TH 229  TH 229  TH 229  TH 220  TH 220  TH 221  TH 223  TH 224  PRINT 57, TM 1  TH 225  TH 226  TH 227  TH 230  TH 231  TH 231  TH 231  TH 233  TH 234  PRINT 72  TH 235  TH 235  TH 235  TH 235			
30 CONTINUE SUM=SUM*DT*VLT TH 204     SUM=SUM*DT*VLT			
SUM=SUM+DT+VLT PRINT 51, 1, 15, SUM  31 ENIN=ENIN+SUM GO TO 35 32 PRINT 56 33 IF (ILGAD_EQ.O) GO TO 37  DO 36 I=1,N  IF (RES(I)_LT.1.E=20) GO TO 36  IF (ITM2.EQ.1) GO TO 34  PRINT 52  ITM2=1  34 CALL CGET (I,CURF,NTRAN) SUM=0.  DO 35 J=1,NTRAN TH 216  SUM=0.  TO 35 J=1,NTRAN TH 217  SUM=SUM+CURF(J)*CURF(J)  SUM=SUM+CURF(J)*CURF(J)  FINT 53, I,RES(I),SUM ENSESUM+CURF(J)*CURF(J)  FONTINUE  36 CONTINUE 37 ENRD=ENLS+SUM TH 223  BONTINUE TH 223  FONTINUE TH 224  TH 225  TH 226  TH 227  TH 226  TH 227  TH 227  TH 228  TH 228  TH 229  TH 229  TH 220  TH 225  TH 227  TH 226  TH 227  TH 227  TH 228  TH 228  TH 229  TH 221  TH 223  TH 224  TH 225  TH 227  TH 228  TH 229  TH 221  TH 223  TH 224  TH 225  TH 227  TH 227  TH 228  TH 229  TH 221  TH 235  TH 231  TH 233  TH 233  TH 234  TH 235			
PRINT 51, I,IS,SUM  I ENIN-ENIN+SUM  GO TO 33  PRINT 56  32 PRINT 56  33 IF (ILOAD_EQ.O) GO TO 37  IF (209  33 IF (ILOAD_EQ.O) GO TO 37  IF (210 OO 36 I=1,N  IF (RES(I)_LT.1.E=20) GO TO 36  IF (ITM2.EQ.1) GO TO 34  PRINT 52  IF (ITM2.EQ.1) GO TO 34  PRINT 52  IF (210 CALL CGET (I,CURF,NTHAN)  SUM=0.  DO 35 J=1,NTHAN  TH 216  SUM=SUM+CURF(J)*CURF(J)  SUM=SUM+DT*RES(I)  PRINT 53, I,RES(I),SUM  ENLS=ENLS+SUM  FOR CONTINUE  TH 223  TH 224  PRINT 54, ENIN,ENLS,ENRO  IF (ENRO,LT.1.E=20) IFEN=0  IF (ENRO,LT.1.E=20) IFEN=0  IF (ENIN,GT.1.E=20) GO TO 38  TH 225  TH 1=100,*ENRO/ENIN  PRINT 55, TM1  GO TO 25  TH 231  GO TO 25  TH 232  PHINT 72  STOP  TH 233  TH 234  TH 235	30		
31 ENIN=ENIN+SUM GO TO 33 32 PRINT 56 33 IF (ILOAD, EQ.O) GO TO 37 DO 36 I=1, N IF (RES(I), LT.1, E-20) GO TO 36 IF (ITM2, EQ.1) GO TO 34 PRINT 52 ITM213 34 CALL CGET (I, CURF, NTRAN) SUM=0. DO 35 J=1, NTRAN SUM=SUM+CURF (J)*CURF (J) SUM=SUM+CURF (J)*CURF (J) SUM=SUM+CURF (J)*SUM ENLS=ENLS*SUM TH 223 36 CONTINUE 37 ENRD=ENIN=ENLS PRINT 54, ENIN, ENLS, ENRO IF (ENRO, LT, 1, E-20) IF EN=0 IF (ENIN, GT,			
GO TO 33 32 PRINT 56 33 IF (ILOAD, EQ., 0) GO TO 37			
PRINT 56	31		
IF (ILOAD, EQ.O) GO TO 37			
DO 36 I=1,N IF (RES(I),LT.1.E=20) GO TO 36 IF (RES(I),LT.1.E=20) GO TO 36 IF (RES(I),LT.1.E=20) GO TO 34 PRINT 52 ITW 213 PRINT 52 ITW 214 ITW 215  CALL CGET (I,CURF,NTRAN) SUM=0. TW 216 SUM=0. TW 217 DO 35 J=1,NTRAN TW 218 SUM=SUM+CURF(J)+CURF(J) SUM=SUM+CURF(J)+CURF(J) SUM=SUM+CURF(J)+CURF(J) TW 220 PRINT 53, I,RES(I),SUM ENLS=ENLS+SUM TW 221 ENLS=ENLS+SUM TW 223 TW 224 PRINT 54, ENIN,ENLS,ENRO IF (ENRO,LT,1.E=20) IFENEO IF (ENRO,LT,1.E=20) GO TO 38 TM 227 IFEN=0 GO TO 25 TM 220 PRINT 55, TM GO TO 25 TM 231 GO TO 25 TM 233 PHINT 72 STOP  C			
IF (RES(I),LT,1,E=20) GO TO 36 IF (ITM2.EQ.1) GO TO 34 PRINT 52 ITM 213 PRINT 52 ITM 215  34 CALL CGET (I,CURF,NTRAN) TW 216 SUM=0. DO 35 J=1,NTRAN TW 217 SUM=SUM+CURF (J)+CURF (J) SUM=SUM+DT+RES(I) PRINT 53, I,RES(I),SUM ENLS=ENLS+SUM TW 221 ENLS=ENLS+SUM TW 223 TW 223 IF (ENRO,LT,1,E=20) IFENEO IF (ENRO,LT,1,E=20) IFENEO IF (ENIN,GT,1,E=20) GO TO 38 TW 225 IF (ENIN,GT,1,E=20) GO TO 38 TM 226 IF (ENIN,GT,1,E=20) GO TO 38 TM 227 IFENEO GO TO 25 TM 210 PRINT 55, TM1 GO TO 25 TM 230 PRINT 55, TM1 TM 231 GO TO 25 TM 233 STOP TW 233	33	IF (ILOAD, EQ. 0) GO TO 37	TW 210
IF (ITM2.EQ.1) GO TO 34 PRINT 52 ITM 214 PRINT 52 ITM 215  34 CALL CGET (I,CURF,NTRAN) SUM=0. DO 35 J=1,NTRAN TH 216 SUM=SUM+CURF(J)*CURF(J) SUM=SUM+CURF(J)*CURF(J) SUM=SUM+CURF(J)*SUM FRINT 53, I,REŚ(I),SUM ENLS=ENLS+SUM TH 220 CONTINUE TH 223 FUND=ENIN-ENLS PRINT 54, ENIN,ENLS,ENRO IF (ENRO.LT.1.E-20) IFEN=0 IF (ENN.GT.1.E-20) IFEN=0 TH 226 IF (ENIN.GT.1.E-20) GO TO 38 TM 227 IFEN=0 GO TO 25 TM 250 TM 251 GO TO 25 TM 231 GO TO 25 TM 232 PHINT 72 TM 233 STOP TM 234 C			
PRINT 52  1TM 214  1TM 215  34		IF (RES(I),LT,1,E=20) GO TO 36	212 MT
1TM2=1			TW 213
34       CALL CGET (I, CURF, NTRAN)       TH 216         SUM=0.       TH 217         DO 35 J=1, NTRAN       TH 218         35       SUM=SUM+CURF (J) **CURF (J)       TH 219         SUM=SUM*DT*RES(I)       TH 220         PRINT 53, I, RES(I), SUM       TH 221         ENLS=ENLS+SUM       TH 223         36       CONTINUE       TH 223         37       ENRO=ENIN=ENLS       TH 224         PRINT 54, ENIN, ENLS, ENRO       TH 225         IF (ENRO, LT, 1, E=20) IFEH=0       TH 226         IF (ENIN, GT, 1, E=20) GO TO 38       TH 227         IFEN=0       TH 228         GO TO 25       TH 230         38       TH=100, *ENRO/ENIN       TH 231         PRINT 55, TMI       TH 233         GO TO 25       TH 233         39       PHINT 72       TH 233         50       TH 234         60       TH 234         70       TH 234         70       TH 235		PRINT 52	TW 214
SUM=0.  DO 35 J=1,NTRAN  TH 217  DO 35 J=1,NTRAN  SUM=SUM+CURF(J)*CURF(J)  SUM=SUM+DT*RES(I)  PRINT 53, I,REŚ(I),SUM  ENLS=ENLS+SUM  TH 221  CONTINUE  TH 223  TH 224  PRINT 54, ENIN,ENLS,ENRO  IF (ENRO,LT,1.E=20) IFEN=0  IF (ENIN,GT,1.E=20) GO TO 38  TH 227  IFEN=0  GO TO 25  TH 230  PRINT 55, TM1  GO TO 25  PRINT 72  STOP  TH 233  TH 234  TH 235			
DO 35 J=1,NTRAN  SUM=SUM+CURF(J)*CURF(J)  SUM=SUM+DT*RES(I)  PRINT 53, I,REŚ(I),SUM  ENLS=ENLS+SUM  TH 223  CONTINUE  TH 223  PRINT 54, ENIN,ENLS,ENRO  IF (ENRO.LT,1.E=20) IFEN=0  IF (ENIN.GT,1.E=20) GO TO 38  TH 227  IFEN=0  GO TO 25  TH 230  PRINT 55, TM1  GO TO 25  TH 233  STOP  TH 235	34	CALL CGET (I, CURF, NTRAN)	
SUM=SUM+CURF(J)*CURF(J)			
SUM=SUM+DT*RES(I) PRINT 53, I,RES(I),SUM ENLS=ENLS+SUM TH 222  36 CONTINUE TH 223  37 ENRD=ENIN-ENLS PRINT 54, ENIN,ENLS,ENRO IF (ENRO,LT,1.E-20) IFEN=0 IF (ENIN,GT,1.E-20) GO TO 38 TH 227 IFEN=0 GO TO 25 TH 230 PRINT 55, TM1 TH 231 GO TO 25 TH 233 PHINT 72 STOP  C			Tw 218
PRINT 53, I,REŠ(I),SUM  ENLS=ENLS+SUM  TH 222  36	35		
ENLS=ENLS+SUM  CONTINUE  ENRD=ENIN-ENLS  PRINT 54, ENIN, ENLS, ENRO  IF (ENRO, LT, 1, E=20) IFEN=0  IF (ENIN, GT, 1, E=20) GO TO 38  TW 227  IFEN=0  GO TO 25  TM 1200  PRINT 55, TM1  GO TO 25  PRINT 72  PRINT 72  STOP  TH 233  TH 234  C			
36			
### STOP    STOP		ENLS=ENLS+SUM	222 MT
PRINT 54, ENIN, ENLS, ENRO  IF (ENRO, LT, 1, E-20) IFEN=0  IF (ENIN, GT, 1, E-20) GO TO 38  IFEN=0  GO TO 25  The 229  The 230  The 231  The 232  The 233  The 233  The 234  The 235			
IF (ENROLLT,1.E=20) IFEN=0 IF (ENIN.GT,1.E=20) GO TO 38 IF 227 IFEN=0 GO TO 25 Th 228 Th 229 Th 230 PRINT 55, Th1 GO TO 25 Th 231 FOR TO 25 Th 232 Th 233 Th 234 Th 235	37		
IF (ENIN.GT.1.E-20) GO TO 38  IF 227  IFEN=0  GO TO 25  TH 228  TH 229  38  TM1=100.*ENRO/ENIN  PRINT 55, TM1  GO TO 25  TH 230  TH 231  STOP  TH 233  TH 233  TH 234  TH 235			
IFEN=0 GO TO 25 Th 229 Th 230 PRINT 55, TM1 GO TO 25 Th 232 PHINT 72 STOP  TH 235			
GO TO 25  Th 229  Th 230  PRINT 55, TM1  GO TO 25  Th 231  FRINT 72  TH 233  STOP  Th 235  TH 235		IF (ENIN.GT.1.E-20) GO TO 38	
38 TM1=100.*ENRO/ENIN PRINT 55, TM1 GO TO 25 TH 232 39 PHINT 72 STOP TH 235 TH 235			855 w.t
PRINT 55, TM1  GO TO 25  TH 232  39 PHINT 72  STOP  TH 233  TH 234  TH 235			7 × 229
GO TO 25 39 PHINT 72 STOP TH 233 TH 234 TH 235	38	TM1=100. *ENRO/ENIN	Tw 230
39 PHINT 72 TH 233 STOP TH 235 C TH 235		PRINT 55, TM1	
39 PHINT 72 TH 233 STOP TH 235 C TH 235		60 10 25	T# 232
C TN 235	34	PRINT 72	TH 233
		STOP	TH 234
C TH 236	C		
			TH 236

```
FORMAT
40
              (A2, 13, 315, 6E10.3)
                                                                            TH 237
      FORMAT
              ( //,1x,15+*** DATA CARD**, A2,13,315,6E12,5)
                                                                            TH 238
41
      FORMAT
                 //,1x,38HINVALID DATA CARD LABEL AFTER SULUTION)
42
                                                                            TW 239
      FURMAT
              (1346)
43
                                                                            TW 240
              (15,21HCURRENTS FROM SEGMENT, 15,6x,4HTAG=,15,2x,10HINCREME TW 241
      FORMAT
     INT= . 15)
                                                                            TW 242
45
      FURMAT
             (6£12.5)
                                                                            TW 243
      FORMAT ( 1x,57HTIME FOR INITIALIZATION OF CONSTANTS=,F9.3,5H SEC TH 244
46
     1.)
                                                                            TW 245
      FORMAT
              ( 1x,26HTIME FOR CURRENT SOLUTION=,F9.3,5H SEC.)
                                                                              246
      FORMAT
                 /,1x,13HRUNNING TIME=,F9.3,5H SEC.)
48
                                                                            TW 247
      FORMAT
49
                 ///,36x,25H- - - ENERGY BUDGET - - -)
                                                                            TW 248
      FORMAT
                 //,33x,9HSOURCES -,//,35x,15HSOURCE SEGMENT,3x,12HENER TW 249
50
     1GY INPUT, /, 37x, 3HNO, , 6x, 3HNO. , 6x, 8H(JOULES))
                                                                            TH 250
      FORMAT
51
              (35x,15,4x,15,5x,E11,4)
                                                                            TW 251
                 //.334, THLOADS -, /, 35x, THSEGMENT, 3x, 10HRESISTANCE, 2x, 11 TH 252
      FORMAT
     [HENERGY LOSS, /, 38x, 3HNO., 7x, 6H(DHMS), 5x, 8H(JOULES))
                                                                            TW 253
53
      FORMAT
              (36x, 15, 2x, 2E12, 4)
                                                                            TW 254
      FORMAT
              ( /,36x,20HTOTAL ENERGY INPUT =,E11.4.7H JOULES,/,36x,22H Tw 255
     1ENERGY LOST IN LOADS =, E11.4, 7H JOULES, /, 36x, 23HTOTAL ENERGY RADIA TH 256
     21ED = , E11.4,7H JULLES)
                                                                            TW 257
              ( 36X, 24HTIME DOMAIN EFFICIENCY =, F7, 2, 8H PERCENT) TH 258
( 7,59HINPUT ENERGY NOT COMPUTED SINCE SOURCE HAS BEEN TR TH 259
55
      FORMAT
56
      FORMAT
     1ANSFORMED)
                     FORMAT (1H1,
     1,/ /,31x,36HTIME DOMAIN ANTENNA MODELING PROGRAM,//,28x,42H******
                                                                           14 595
                                                                            T# 263
58
      FORMAT (A2,13A6)
                                                                            TW 264
59
      FORMAT
              (28x,1346)
                                                                            TW 265
      FURMAT (//// 33x.33H- - - SEGMENTATION DATA - - - , //,40x,
00
                                                                            TH 266
       21HCOURDINATES IN METERS, //, 25x,
                                                                            TH 267
        SOHI+ AND I- INDICATE THE SEGMENTS BEFORE AND AFTER I.//)
                                                                            TH 268
      FORMAT (2x,4HSEG., 3x, 26HCOORDINATES OF SEG. CENTER, 5x, 4HSEG.,
61
                                                                            TA 269
     1 5x,18HORIENTATION ANGLES,4x,4HWIRE,5x,15HCONNECTION DATA,4x,
                                                                            TW 270
          3HTAG, /, 2X, 3HNO., 7X, 1HX, 9X, 1HY, 9X, 1HZ, 7X, 6HLENGTH, 5X, 5HALPHA,
                                                                            T# 271
        5x, 4HBETA, 6x, 6HRADIUS, 4x, 2HI-, 4x, 1HI, 5x, 2HI+, 4x, 3HNO.)
                                                                            TW 272
62
      FORMAT (1x,15,4F10,5,1x,3F10,5,316,2X,15)
                                                                            TW 273
63
      FOHMAT
              (2E10,3,15,2x,3A1,315)
                                                                            T# 274
                //.1x,21H*** FIRST DATA CARD**, 2E12.5, 15, 2x, 3A1, 315)
64
      FORMAT
                                                                            TW 275
              (
      FORMAT (
                  //,1x,19HNUMBER OF SEGMENTS=,17,/,1x,18HTOTAL WIRE LENG TH 276
65
     1TH=,F10.5,3H M.,/,1X,23HMAXIMUH SEGMENT LENGTH=,F10.5,3H M.)
                                                                            T# 277
                 ///.1x, 21HOPTIONS SELECTED - - -,/)
                                                                            T# 278
66
      FORMAT
                  SH THE . 41.37H=0 PLANE IS A MAGNETIC SYMMETRY PLANE)
      FORMAT
                                                                            TW 279
67
                 SH THE , A1, 38H=0 PLANE IS AN ELECTRIC SYMMETRY PLANE)
68
      FORMAT
                                                                            TA 280
69
                 1x,27HHODEL HAS IMPEDANCE LUADING)
      FORMAT
                                                                            185 WT
70
      FURMAT
                 1x, 19HMODEL IS NOT LUADED)
                                                                            TW 282
      FORMAT ( 1x,37HCURHENTS WILL BE PRINTED FOR SEGMENTS,15.8H THROU TA 283
71
     1GH , 15)
                                                                            TH 284
              (1x, 25HZERO TIME STEPS REQUESTED)
72
                                                                            Tm 285
             73
      FORMAT
     1x, 23HTIME STEPPING INTERVAL=, E12, 5, SH SEC. , /, 1x, 13H44XIMUH TIME=,
         E12,5,5H SEC../,1X,21HNUMBER OF TIME STEPS=,16,//,41H A**A**AA*
                                                                           In 288
                                                                            TH 289
     3**********************
      FORMAT ( ///.35x,33H- - - - STRUCTURE LOADING - - - -.//.23x, TH 290 BOHTAG INCREMENT SEG. RESISTANCE INDUCTANCE CAPACITANCE TA 291
74
     2./ .23x,3HNO.,14x,3HNO.,5x,6H(QHMS).6x,8H(HENRYS),6x,8H(FARADS))
                                                                            TA 292
75
      FORMAT (315,5x, 5810,5)
                                                                            TW 293
      TAMMOT
              (21x,15,5x,15,2x,15,3x,E10,4,3x,E10,4,4x,E10,4)
                                                                            TW 294
             (1x, 34HINCORRECT LABEL FOR A CUMMENT CARD)
      FORMAT
                                                                            Ta 295
      END
                                                                            TH 296-
```

```
SUBROUTINE ANTRAN (ISEG, ANOR, IPCH)
                                                                                  AN
                                                                                  AN
                                                                                        2
C
       ANTRAN COMPUTES AND PRINTS THE INPUT ADMITTANCE AND IMPEDANCE AT
                                                                                        3
C
                                                                                  AN
C
      SEGMENT ISEG
                                                                                  AN
      COMMON /DATA/ N,NP,X(200),Y(200),Z(200),SI(200),BI(200),ALP(200),
                                                                                  AN
          BET(200), ICON1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ
                                                                                  AN
     1
      COMMON /ESDRC/ ESDRC(1024), IFST, NTRAN, MTRAN, NTNX, DFRQ, ENIN, ENRO, I AN
     1FEN
                                                                                  AN
      CUMMON /CMAT/ CURF(1600), IP(200), IX(200)
                                                                                  AN
                                                                                       10
      COMMON /CONST/ CDT, VEL, DT, NTSTEP
COMMON /ASURC/ EMAG(10), ISRC(10), NSRC
                                                                                  AN
                                                                                       11
                                                                                  AN
                                                                                       12
       COMMON /SCHATH/ PHR(512)
                                                                                  AN
                                                                                       13
      COMPLEX YMIT, Z
                YMIT, ZPED, ZNOR
                                                                                  AN
                                                                                       14
                                                                                  AN
                                                                                       15
      IF (IFST.EG.1) GO TO 2
                                                                                  AN
                                                                                       16
                                                                                  AN
                                                                                       17
       FOURIER TRANSFURM SOURCE
                                                                                  AN
                                                                                       18
                                                                                  AN
                                                                                       19
       MTRAN=ALOG(FLOAT(NTRAN))/.69314718+1.5
                                                                                  AN
                                                                                       20
      CALL ITOF (ESORC, NTRAN, MTRAN, 1, 1, NTNX, NTNR)
                                                                                  AN
                                                                                       21
       IFST=1
                                                                                  AN
                                                                                       22
       DFRG=1./(DT*FLUAT(2**MTRAN))
                                                                                  AN
                                                                                       53
      NTNR=NTNR/2
                                                                                  AN
                                                                                       24
      DO 1 I=1, NTNR
                                                                                  AN
                                                                                       25
      PWR(1)=0.
                                                                                  AN
                                                                                       26
      CALL CGET (ISEG, CURF, NTRAN)
                                                                                  AH
                                                                                       27
C
                                                                                  AN
                                                                                       28
C
      FOURIER TRANSFORM CURRENT
                                                                                  AN
                                                                                       29
                                                                                       30
                                                                                  AN
      CALL ITOF (CURF, NTRAN, MTRAN, O, O, NTNX, NTNR)
                                                                                       31
                                                                                  AN
       INDR=0
      IF (ABS(ANOR), GT. 1. E-20) INOR=1
                                                                                  MA
                                                                                       33
       IF (NSRC.LT.1) GO TO 4
                                                                                  AN
                                                                                       34
      DO 3 I=1. NSRC
                                                                                  AN
                                                                                       35
                                                                                  AN
       11=1
                                                                                       36
       IF (ISRC(I).EQ.ISEG) GO TO 5
                                                                                  AN
                                                                                       37
      CONTINUE
3
                                                                                  AN
                                                                                       38
       VLT=1.
                                                                                  AN
                                                                                       39
      ISPR=0
                                                                                  AN
                                                                                       40
       GO TO 6
                                                                                  AN
                                                                                       41
       VLT=EMAG(11) +SI(ISEG)
                                                                                  HA
                                                                                       42
       ISPR= 1
                                                                                  AN
                                                                                       43
       PRINT 10. ISEG, VLT
                                                                                  AN
                                                                                       44
      IF (INOR, EQ. 1) PRINT 11, ANDR
                                                                                       45
                                                                                  AN
      PRINT 12
                                                                                       45
      DF=DF#0+1.E-6
                                                                                  AN
                                                                                       47
      F=+OF
                                                                                  AN
                                                                                       UB
      FMAX=1, E-6/(TSMIN+DT)
                                                                                  AN
                                                                                       49
       SINTHE SATA
                                                                                  AN
                                                                                       50
       IF (IPCH.NE.O) PUNCH 15
                                                                                  AN
                                                                                       51
      NALN'IEI 8 00
                                                                                  AN
                                                                                       52
       F=F+DF
                                                                                  AN
                                                                                       55
      IF (F.GT.FMAX) GO TO 9
                                                                                  AN
                                                                                       54
       12=2*1
                                                                                  AN
                                                                                       55
      Ilals-1
                                                                                  AN
                                                                                       56
```

```
YMIT=CMPLX(ESORC(II), ESORC(IZ)) *VLT
                                                                                 AN
                                                                                     57
      SPCT=CABS(YMIT)
                                                                                 AN
                                                                                      58
      YMIT=CMPLX(CURF(I1), CURF(I2))/YMIT
                                                                                 AN 59
      ZPED=1./YMIT
                                                                                 AN
                                                                                     60
      IF (ISPR.EQ.1) PWR(I)=PWR(I)+.5*VLT*VLT*REAL(YMIT)
                                                                                 MA
                                                                                      61
      IF (IPCH. NE. 0) PUNCH 14, I,F, ZPED, YMIT
                                                                                 AN
                                                                                     62
      IF (INOR.EQ.O) GO TO 7
                                                                                 AN
                                                                                     63
      ZNUR=ZPED/ANOR
                                                                                 AN
                                                                                      64
      PRINT 13, I,F, ZPED, YMIT, ZNOR, SPCT
                                                                                 AN
                                                                                      65
      GO TO 8
                                                                                 AN
                                                                                      66
      PRINT 14.
                                                                                     67
                  I,F, ZPED, YMIT, SPCT
                                                                                 AN
8
      CONTINUE
                                                                                 AN
                                                                                      68
      RETURN
                                                                                 AN
                                                                                      69
C
                                                                                 AN
                                                                                      70
                                                                                      71
10
      FORMAT ( //, 24x, 50H - - ANTENNA INPUT IMPEDANCE AND ADMITTANCE
                                                                                      72
     1= - -,//,31x,23HSOURCE SEGMENT NUMBER =,15,/,31x,21HPEAK SOURCE VO AN
                                                                                     73
                                                                                 AN
                                                                                      74
     2LTAGE =, E11.4, OH VOLTS)
      FORMAT (31x,32HIMPEDANCE NURMALIZATION FACTOR =,E11.4,5H OHMS)
FORMAT ( /,1x,4HSTEP,4x,9HFREQUENCY,6x,16HIMPEDANCE (OHFS),10x,
                                                                                 AN
                                                                                      75
11
15
                                                                                 AN
                                                                                     76
         17HADMITTANCE (MHOS), 7X, 20HNORMALIZED IMPEDANCE, 6X, 6HSOURCE, /,
                                                                                 AN
                                                                                      77
     2 2x,3HNO,,6x,5H(MHZ),3(Ax,4HREAL,8x,5HIMAG,,1x), M,8HSPECTRUM)
                                                                                 AN
                                                                                      78
13
      FORMAT (1x,14,2613,4,612,4,2(614,4,612,4),2x,611,4)
                                                                                 AN
                                                                                     79
                                                                                 AN 80
      FORMAT (1x,14,2E13,4,E12,4,E14,4,E12,4,28x,E11,4)
14
      FORMAT (9x, 9HFREQUENCY, 9x, 9HIMPEDANCE, 18x, 10H4DHITTANCE)
15
                                                                                 AN
                                                                                     81
      END
                                                                                 AN 82.
```

	FUNCTION ATGNZ (X,Y)	AT	1
C	17010 10 1007110011 501 41101	AT	5
	ATGNZ IS ARCTANGENT FUNCTION MODIFIED TO RETURN O, WHEN XEYEO.	AT	3
C		AT	4
	IF (x) 3,1,3	AT	5
1	IF (Y) 3,2,3	AT	6
2	ATGN2=0.	AT	7
	RETURN	AT	A
3	ATGNZEATANZ(X,Y)	AT	a
	RETURN	AT	10
	END	AT	11-

	SUBROUTINE CGET (ISEG, CSEG, NLM)	CG	1
C		CG	5
CCC	CGET FILLS ARRAY CSEG WITH THE CURRENT ON SEGMENT ISEG FOR ALL	CG	3
C	TIME STEPS	CG	4
C		CG	5
	COMMON /DATA/ N,NP,X(200),Y(200),Z(200),SI(200),BI(200),ALP(200),	CG	6
	1 BET(200), ICON1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ	CG	7
	COMMON /ARRAY/ CQ(6400)	CG	8
	COMMON /IDFLG/ NCFMX, NCGMX, IOC, IUCG, NTMAX, NBOUT, JP1, JP2	CG	9
	DIMENSION CSEG(1024)	CG	10
	II=N*2	CG	11
	18=2 * I SEG = 1	CG	12
	1=18-11	CG	13
	NOCQ=99999	CG	14
	IF (IDCQ.EQ.0) GO TO 1	CG	15
	REWIND 11	CG	16
	READ (11) NOCQ, (CQ(K), K=1, NOCQ)	CG	17
1	DO 3 J=1.NLM	CG	18
	1=1+11	CG	19
	IF (I.LE.NOC9) GO TO 2	CG	20
	READ (11) NOCQ, (CQ(K), K=1, NOCQ)	CG	21
	I=18	CG	55
2	CSEG(J)=CQ(I)	CG	23
3	CONTINUE	CG	24
-	IF (IOCQ.NE.O) REWIND 11	CG	25
	RETURN	CG	
	END	150	26
	CHU	CG	27-

```
SUBROUTINE COFS (CURF, CURL, NOIM)
                                                                                CF
C
                                                                                CF
      COFS SETS UP THE ARRAYS OF INTERACTION COEFFICIENTS FOR BOTH
C
                                                                                CF
      PRESENT TIME AND RETARDED TIME INTERACTION
C
                                                                                CF
                                                                                CF
      COMMON /DATA/ N.NP,X(200),Y(200),Z(200),SI(200),BI(200),ALP(200),
                                                                                CF
        BET(200), ICUN1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ
                                                                                CF
     1
      COMMON /SCOMP/ SX(200), SY(200), SZ(200)
                                                                                CF
      COMMON /CONST/ CDT, VEL, DT, NTSTEP
                                                                                CF
                                                                                     9
      COMMON /ARRAY/ CA(6400)
                                                                                CF
                                                                                     10
      COMMON /ARRAX/ Q11,Q12,Q13,EC(200,5),EQ(200,5),IRET(200),BFR(15400 CF
                                                                                    11
     1)
                                                                                CF
      COMMON /EMATS/ EMX(3,3), EMY(3,3), EMZ(3,3), QMX(3,3), QMY(3,3), QMZ(3, CF
     13)
                                                                                CF
                                                                                    14
      COMMON /LOAD/ RES(200), ELD(200), CAP(200), ILOAD
                                                                                CF
                                                                                    15
      COMMON /INFLG/ NCFHX, NCQMX, IOC, IOCQ, NTMAX, NBUUT, JP1, JP2
                                                                                CF
                                                                                    16
      COMMON /MATPAR/ NBLOKS, NPBLK, NLAST, INT
                                                                                CF
                                                                                    17
      DIMENSION CURF (NDIM, NDIM), CURL(1)
                                                                                CF
      DIMENSION CUF(17600), ICOF(17600), SRT(5400), ISRT(6400)
                                                                                CF
                                                                                    19
      DIMENSION ALFA(3,3), BETA(3,3)
                                                                                CF
                                                                                    20
      EQUIVALENCE (COF, EC), (ICOF, EC), (SRT, CO), (ISRT, CO)
                                                                                CF
                                                                                    21
      LPX=1
                                                                                CF
                                                                                    22
      LPY=1
                                                                                CF
                                                                                     23
      LPZ=1
                                                                                CF
                                                                                    24
      IF (IPX.NE.0) LPX=2
                                                                                CF
                                                                                    25
      IF (IPY. NE. 0) LPY=2
                                                                                CF
                                                                                    26
      IF (IPZ.NE.O) LPZ=2
                                                                                CF
                                                                                    27
      ICNTC=0
                                                                                CF
                                                                                    28
                                                                                CF
                                                                                    29
      ICNTS=0
      ICTUT=0
                                                                                CF
                                                                                    30
      IOC=0
                                                                                CF
                                                                                    31
      105=0
                                                                                CF
                                                                                    35
      ICOF (NCFMX) = 9898989
                                                                                CF
                                                                                    33
      ISRT (NCQMx)=9898989
                                                                                CF
                                                                                    34
      IST=2*N*LPX*LPY*LPZ
                                                                                CF
                                                                                    34 A
                                                                                CF
      ICMAX=NCFMX-181
                                                                                    35
                                                                                CF
      ISMAX=NCQMX=IST
                                                                                    36
      IST=1
                                                                                CF
                                                                                    37
                                                                                CF
      NTMAXEO
                                                                                    38
      IF (INT.EQ.O) GO TO 1
                                                                                CF
                                                                                    39
                                                                                CF
      REWIND 13
                                                                                    40
      NOULKS=NBLUKS
                                                                                CF
                                                                                    41
      12=NPBLK*N
                                                                                CF
                                                                                    42
                                                                                CF
      IT=NPBLK
                                                                                    43
      GO TO 2
                                                                                CE
                                                                                    44
                                                                                CF
      NOBLKS=1
                                                                                    45
      ITEN
                                                                                CF
                                                                                    46
                                                                                CF
5
      1 .0
                                                                                    47
C
                                                                                CF
                                                                                    48
      BEGIN LOUP OVER FIELD EVALUATION POINTS
                                                                                CF
                                                                                    49
C
                                                                                CF
                                                                                    50
      DO 30 109LKS=1, NOBLKS
                                                                                CF
                                                                                    51
      IF (1N1.E0.0) GO TO 5
                                                                                CF
                                                                                    52
      IF (IUBLKS, EQ, NOBLKS) IT=NLAST
                                                                                CF
                                                                                    53
                                                                                CF
                                                                                    54
      DO 29 19=1, IT
3
      I=I+1
                                                                                CF
                                                                                    55
```

```
XI = X(I)
                                                                                CF
                                                                                    56
      YIEY(I)
                                                                                CF
                                                                                    57
      Z1=Z(1)
                                                                                CF
                                                                                    58
      SXI=SX(I)
                                                                                CF
                                                                                    59
      SYIESY(I)
                                                                                CF
                                                                                    60
      SZI=SZ(I)
                                                                                CF
                                                                                    61
      DO 4 J=1, N
                                                                                CF
                                                                                    62
      CURF (J, 18) = 0.
                                                                                CF
                                                                                    63
      IFL=0
                                                                                CF
                                                                                    64
C
                                                                                CF
                                                                                    65
      BEGIN LOOP OVER SOURCE SEGMENTS INCLUDING IMAGES
                                                                                CF
                                                                                    66
                                                                                CF
                                                                                    67
      DO 29 JX=1, LPX
                                                                                CF
                                                                                    68
      RFX=FLOAT (3-JX+2)
                                                                                CF
                                                                                    69
      SFX=RFX
                                                                                CF
                                                                                    70
      IF (IPX.LT.0) SFX=1.
                                                                                CF
                                                                                    71
      DO 29 JY=1, LPY
                                                                                CF
                                                                                    72
      RFY=FLUAT (3-JY+2)
                                                                                CF
                                                                                    73
      SFY=RFY
                                                                                CF
                                                                                    74
      IF (IPY.LT.0) SFYE1.
                                                                                CF
                                                                                    75
      DO 29 JZ=1.LPZ
                                                                                CF
                                                                                    76
      RFZ=FLOAT(3-JZ*2)
                                                                                CF
                                                                                    77
      SFZ=RFZ
                                                                                CF
                                                                                    78
                                                                                CF
      IF (IPZ.LT.0) SFZ=1.
                                                                                    79
      RFL=SFX+SFY+SFZ
                                                                                CF
                                                                                    80
      NTL=0
                                                                                CF
                                                                                    81
      DU 5 J=1, N
                                                                                CF
                                                                                    82
      RX=XI-X(J)+RFX
                                                                                CF
                                                                                    83
      RY=YI=Y(J)*RFY
                                                                                CF
                                                                                    84
      RZ=ZI+Z(J)*RFZ
                                                                                CF
                                                                                    85
      R=SQRT(RX*RX+RY*RY+RZ*RZ)
                                                                                CF
                                                                                    86
      K=R/CDT+.5
                                                                                CF
                                                                                    87
      IF (K.EQ.0) K=1
                                                                                CF
                                                                                    88
      IRET(J)=K
                                                                                CF
                                                                                    89
      IF (K.GT.NTL) NTL=K
                                                                                CF
                                                                                    90
                                                                                CF
      DO 5 M=1,5
                                                                                    91
      EC(J, M) = 0.
                                                                                CF
                                                                                    92
      EQ(J, M) = 0.
5
                                                                                CF
                                                                                    93
      DO 21 J=1.N
                                                                                CF
                                                                                    94
      RX=XI-X(J)+RFX
                                                                                CF
                                                                                    95
      RY=YI-Y(J)*RFY
                                                                                CF
                                                                                    96
      HZ=ZI-Z(J)*HFZ
                                                                                CF
                                                                                    97
                                                                                CF
      R2=RX*RX+RY*RY+RZ*RZ
                                                                                    98
      R=SGRT(R2)
                                                                                CF
                                                                                    99
                                                                                CF 100
      K=IRET(J)
      TAU=OT*FLOAT(K)
                                                                                CF 101
                                                                                CF 102
      SXJ=SX(J) +RFX
                                                                                CF 103
      SYJ=SY(J) *RFY
                                                                                CF 104
      SZJ=SZ(J) + RFZ
                                                                                CF 105
      CALL EMAT (RX,RY,RZ,RZ,TAU,SXJ,SYJ,SZJ,J)
      DO 6 L=1,3
                                                                                CF 105
                                                                                CF 107
      00 6 Ma1,3
      ALFA(L,M)=(EHX(L,M)+SXI+EHY(L,M)+SYI+EMZ(L,M)+SZI)+RFL
      BETA(L, M) = (QMX(L, M) *SXI+QMY(L, M) *SYI+GMZ(L, M) *SZI) *RFL
                                                                                CF 109
      JC1=ICON1(J)
                                                                                CF 110
      IF (JC1. NE. 0) GO TO 7
                                                                                CF 111
                                                                                CF 112
      KKM=0
      GO TO 11
                                                                                CF 113
                                                                                CF 114
      IF (JC1.LT.19000) GD TO 8
                                                                                CF 115
      SIG1=FLOAT (JC1-20000)
```

```
JCI=J
                                                                                  CF 116
      GO TO 10
                                                                                  CF 117
       IF (ICON2(JC1).NE.J) GO TO 9
                                                                                  CF 118
      SIG1=1.
                                                                                  CF 119
      GO TO 10
                                                                                  CF 120
                                                                                  CF 121
      IF (ICON1 (JC1) . NE. J) GO TO 44
      SIG1 = -1 .
                                                                                  CF 122
      KM=IRET(JC1)
                                                                                  CF 123
                                                                                  CF 124
      KKM=KM-K
      IF (IABS(KKM), LE. 1) GO TO 11
                                                                                  CF 125
      PRINT 45, I, J, JC1, KKM
                                                                                  CF 126
      STOP
                                                                                  CF 127
      JC2=ICUN2(J)
                                                                                  CF 128
       IF (JC2.NE.0) GO TO 12
                                                                                  CF 129
      KKPEO
                                                                                  CF 130
                                                                                  CF 131
      GO TO 16
      IF (JC2.LT.19000) GO TO 13
12
                                                                                  CF 132
       SIG2=FLOAT (JC2-20000)
                                                                                  CF 133
                                                                                  CF 134
      JC2=J
      GO TU 15
                                                                                  CF 135
                                                                                  CF 136
CF 137
13
      IF (ICON1 (JC2) . NE . J) GO TO 14
      S1G2=1.
      GO TO 15
                                                                                  CF 138
                                                                                  CF 139
CF 140
      IF (ICONS(JCS).NE.J) GO TO 44
      SIG2=-1.
      KP=IRET(JC2)
                                                                                  CF 141
15
      KKP=KP=K
                                                                                  CF 142
       IF (IABS(KKP).LE.1) GO TO 16
                                                                                  CF 143
                                                                                  CF 144
      PRINT 45, I, J, JC2, KKP
                                                                                  CF 145
      STOP
      00 20 M=1,3
                                                                                  CF 146
15
      KXX=M+1
                                                                                  CF 147
                                                                                  CF 148
      KMX=KKM+KXX
      KPX3KKP+KXX
                                                                                  CF 149
      KK=K=M+2
                                                                                 CF 150
CF 151
      IF (KK.EQ.0) GO 10 18
      IF (JC1.EQ.0) GO TO 17
                                                                                  CF 152
      EC(JC1, KMX) = EC(JC1, KMX) + ALFA(1, M) + SIG1
                                                                                  CF 153
      EQ(JC1,KMX)=EQ(JC1,KMX)+BETA(1,M)+SIG1
                                                                                  CF 154
      EC(J,KXX)=EC(J,KXX)+ALFA(2,M)
                                                                                  CF 155
17
      EQ(J,Kxx)=EU(J,Kxx)+BETA(2,M)
                                                                                  CF 156
                                                                                 CF 157
CF 158
      IF (JC2.EQ.0) 00 TO 20
      EC(JC2, KPX) = EC(JC2, KPX) + ALFA(3, M) + SIG2
      EQ(JC2, KPX)=EQ(JC2, KPX)+BETA(3, M)+SIG2
                                                                                  CF 159
      GO TO 20
                                                                                  CF 160
      IF (JC1.EQ.0) GO TU 19
                                                                                  CF 161
      CURF (JC1, 18) = CURF (JC1, 18) - (ALFA(1, 3) + BETA(1, 3) + RI3) + SIG1
                                                                                  CF 162
      EQ(JC1,KMX)=EQ(JC1,KMX)+BETA(1,M)+SIG1
                                                                                  CF 163
      CURF (J, IB) = CURF (J, IB) - ALFA(2,3) - BETA(2,3) +QI3
                                                                                  CF 164
      EQ(J, KXX) = EQ(J, KXX) + BETA(2, M)
                                                                                  CF 165
      IF (JC2.EQ.0) GO TO 20
                                                                                  CF 166
      CURF (JC2, 18) = CURF (JC2, 18) - (ALFA(3,3)+BETA(3,3)+GI3)+SIG2
                                                                                 CF 167
      EQ(JC2, KPX) = EQ(JC2, KPX) + BETA(3, M) + SIG2
                                                                                  CF 168
      CONTINUE
                                                                                 CF 109
50
21
      CONTINUE
                                                                                  CF 170
C
                                                                                 CF 171
      ADD TERMS DUE TO LUADING
C
                                                                                  CF 172
                                                                                 CF 173
      IF (ILUAD, EU. 0) GO TO 22
                                                                                 CF 174
      IF (IFL.EQ. 1) 60 TO 22
                                                                                  CF 175
```

```
CF 176
CF 177
      EC(1,2)=EC(1,2)=ELD(1)*.5/(DT*S1(1))
      EC(1,3)=EC(1,3)+ELD(1)+2./(D1+SI(1))
      CURF(I, IH) = CURF(I, IH) + (RES(I) + ELD(I) +1.5/01)/SI(I)
                                                                                 CF 178
      IF (CAP(I).LT.1.E-20) GO TO 22
                                                                                CF 179
      CURF(I, IB) = CURF(I, IB) + Q13/(CAP(I) + SI(I))
                                                                                CF 180
      EQ(1,4)=EQ(1,4)-1./(CAP(1)+SI(1))
                                                                                CF 181
                                                                                CF 182
55
      NTL=NTL+2
      IF (NTL.GT.NTMAX) NTMAX=NTL
                                                                                CF 185
CC
                                                                                CF 184
      SORT COEFFICIENTS FOR FIELD EVALUATION SEGMENT I
                                                                                 CF 185
                                                                                CF 186
      DO 28 LL=1, NTL
                                                                                CF 187
      L=NTL-LL
                                                                                CF 188
      IHDG=0
                                                                                CF 189
      J=0
                                                                                 CF 190
23
      J=J+1
                                                                                CF 191
      IF (J.GT.N) GO TO 28
                                                                                CF 192
      K=IRET(J)
                                                                                CF 193
      KDI = = K-L
                                                                                CF 194
      IF (TABS(KDIF).GT.2) GO TU 23
IF (IHDG.EG.1) GU TU 24
                                                                                CF 195
                                                                                CF 196
       IHDG=1
                                                                                CF 197
      ISRT(IST) =- (L *10000+1)
                                                                                CF 198
      IST=IST+1
                                                                                CF 199
24
      KK=J
                                                                                CF 200
      KKP=IST
                                                                                CF 201
                                                                                CF 202
      IST=IST+1
      SRT(IST)=EC(J,KDIF+3)
                                                                                CF 203
                                                                                CF 204
      SRT(IST+1)=EQ(J,KDIF+3)
      IST=IST+2
                                                                                CF 205
                                                                                CF 206
       J = J + 1
      IF (J.GT.N) GO TO 26
                                                                                CF 207
                                                                                CF 208
      K=IRET(J)
      KDIF=K-L
                                                                                 CF 209
      IF (IABS(KDIF).LT.3) GO TO 25
                                                                                CF 210
                                                                                CF 211
       ISRT(KKP)=20000*(J-KK)+2*KK-1
      IF (1ST, LT, ISMAX) GO TO 23
                                                                                CF 212
      IF (105.EQ.1) GO TO 27
                                                                                CF 213
       IOS=1
                                                                                CF 214
                                                                                CF 215
      REWIND 11
                                                                                CF 216
27
      IST=IST-1
       WRITE (11) IST, (SRT(K), K=1, IST)
                                                                                CF 217
                                                                                CF 218
       ICATS=ICATS+1
      IST=1
                                                                                CF 219
                                                                                CE 550
      GO TO 23
      CONTINUE
                                                                                155 43
                                                                                CF 222
      IFL=1
58
      CONTINUE
                                                                                CF 223
      1F (IN1.EQ.0) GO TO 30
                                                                                CF 224
                                                                                CF 225
      WRITE (13) (CURL(I), I=1,12)
      CONTINUE
                                                                                CF 226
      IF (INT.NE.O) HENIND 13
                                                                                CF 227
C
                                                                                CF 228
      SURT ALL CUEFFICIENTS ACCORDING TO RETARDED TIME
                                                                                CF 229
C
C
                                                                                CF 230
      ISHT(IST)=0
                                                                                CF 231
                                                                                CF 232
      IF (108.EQ.0) GO TO 31
      WRITE (11) IST, (SRT(J), J=1, IST)
                                                                                CF 233
      ICNTS=ICNTS+1
                                                                                CF 234
                                                                                CF 235
      REWIND 11
```

```
ICFai
                                                                                  CF 236
                                                                                 CF 237
      DO 40 LL=1,NTMAX
      L=NTMAX-LL
                                                                                  CF 238
      IST=1
                                                                                 CF 239
      ISL = 9999999
                                                                                  CF 240
                                                                                  CF 241
      IF (103.EQ.0) GO TO 34
                                                                                 CF 242
      ISLEO
      REWIND
                                                                                  CF 243
      GO TO 34
IF (-INDX/10000,EQ.L) GO TO 33
                                                                                  CF 244
                                                                                  CF 245
                                                                                 CF 246
      IHOG=0
      60 10 34
                                                                                  CF 247
      IHDG=1
                                                                                  CF 248
33
                                                                                 CF 249
      ICOF (ICF) = INDX
      ICF=ICF+1
                                                                                  CF 250
      IF (IST.LE.ISL) GO TO 35
                                                                                  CF 251
                                                                                 CF 252
      READ (11) ISL, (SRT(J), J=1, ISL)
                                                                                  CF 253
                                                                                 CF 254
35
      INDX=ISRT(1ST)
      IST=IST+1
                                                                                  CF 255
      IF (INDX) 32,40,36 .
                                                                                 CF 256
      KK=INDX/10000
                                                                                 CF 257
      1F (IHOG.EQ.0) GO TO 39
                                                                                  CF 258
                                                                                 CF 259
      ICUF (ICF) = INDX
      ICF = ICF +1
                                                                                  CF 260
                                                                                 CF 261
      KKPSIST
                                                                                 CF 262
      00 37 J=1,KK
      COF(ICF)=SRT(KKP)
                                                                                  CF 263
                                                                                 CF 264
      ICF=ICF+1
      KKP=KKP+1
                                                                                  CF 265
                                                                                 CF 266
      IF (ICF.LT.ICMAX) GO TO 39
      IF (100,EQ.1) GO TO 38
                                                                                  CF 267
                                                                                 CF 268
      IOC=1
      REWIND 12
                                                                                  CF 269
      ICF = ICF - 1
                                                                                  CF 270
36
      WRITE (12) ICF, L, (COF(J), J=1, ICF)
                                                                                 CF 271
      ICTOT=ICTOT+ICF
                                                                                  CF 272
                                                                                 CF 273
       ICHTC=ICHTC+1
      ICF=1
                                                                                  CF 274
      IST=IST+KK
                                                                                 CF 275
39
      GO TO 34
                                                                                  CF 276
                                                                                 CF 277
      CUNTINUE
40
                                                                                 CF 278
      ICOF(ICF)=0
      IF (100,EQ.0) GO TO 41
WRITE (12) ICF,L,(COF(J),J=1,ICF)
                                                                                  CF 279
                                                                                 CF 280
      ICTOT=ICTOT+ICF
                                                                                 CF 281
                                                                                 CF 282
      ICNTC=ICNTC+1
      REWIND 12
                                                                                 CF 283
      IF (108, EQ. 1) REWIND 11
                                                                                 CF 284
      1F (1SRT(NCQMX), NE, 9898989) GO TO 42
                                                                                 CF 285
      IF (ICUF(NCFMX), NE, 9898989) GU TU 43
IF (ICNTC.EQ.O) ICTOT=ICF
                                                                                 CF 286
                                                                                 CF 287
      PRINT 49, ICTOT, ICNTS, ICNTC
                                                                                 CF 258
                                                                                 CF 289
      RETURN
      PRINT 46
                                                                                 CF 290
42
      STUP
                                                                                 CF 291
      PRINT 47
                                                                                 CF 292
43
      STOP
                                                                                 CF 293
      PRINT 48, J
                                                                                 CF 294
                                                                                 CF 295
      STOP
```

```
CF 296
45
FORMAT (1x,27HRETARDED TIMES FROM SEGMENT,15,12H TO SEGMENTS,15, CF 297
1 4H AND,15,10H DIFFER BY,15,11H TIME STEPS)
CF 298
46
FORMAT (1x,29HOVERFLOW IN FILLING ARRAY SHT)
CF 299
47
FORMAT (1x,29HOVERFLOW IN FILLING ARRAY COF)
CF 300
48
FORMAT (1x,29HSEGMENT CONNECTION ERROR, J=,15)
FORMAT (1x,29HSEGMENT CONNECTION ERROR, J=,15)
FORMAT (1x,29H LENGTH OF COEFFICIENT ARRAY=,110,/,1x,110,1x, CF 302
1 25HBLOCKS OUTPUT TO FILE 11,,1x,110,1x,24HBLOCKS OUTPUT TO FILE 1 CF 303
22,/)
END
CF 305=
```

```
SUBROUTINE CONECT
                                                                               CT
C
                                                                               CT
      CONNECT SETS UP SEGMENT CONNECTION DATA IN ARRAYS ICON1 AND ICON2
C
      BY SEARCHING FOR SEGMENT ENDS THAT ARE IN CONTACT.
                                                                               CT
C
      COMMON /DATA/ N,NP,X(200),Y(200).Z(200),SI(200),BI(200),ALP(200),
     1 RET(200), ICON1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ
                                                                               CT
      DIMENSION x2(1), Y2(1), Z2(1)
                                                                               CT
                                                                                    8
      EQUIVALENCE (X2(1), SI(1)), (Y2(1), ALP(1)), (Z2(1), BET(1))
                                                                               CT
      SMIN=1.E-3
                                                                               CT
                                                                                  10
                                                                               CT
      JN0=0
                                                                                  1 1
      DO 1 I=1, N
                                                                               CT
                                                                                   15
      ICON1(1)=0
                                                                               CT
                                                                                  13
                                                                               CT
      ICUNS(1)=0
                                                                                  14
      DO 33 1=1, N
                                                                               CT
                                                                                   15
                                                                               CT
                                                                                  16
      XI1=X(1)
      YI1=Y(I)
                                                                               CT
                                                                                  17
      ZI1=Z(I)
                                                                               CT
                                                                                   18
                                                                               CT
                                                                                  19
      (I) 5x=51x
      A15=A5(1)
                                                                               CT
                                                                               CT
      212=22(1)
                                                                                   21
      SLEN=SQRT((X12-X11)**2+(Y12-Y11)**2+(Z12-Z11)**2)
                                                                               CT
                                                                                   55
                                                                               CT
C
                                                                                  23
      DETERMINE CONNECTION DATA FOR END 1 OF SEGMENT.
C
                                                                               CT
                                                                                  24
                                                                               CT
                                                                                  25
C
      IF (IPX.EQ.0) GO TO 3
                                                                               CT
                                                                                   25
      SEP=XI1/SLEN
                                                                               CT
                                                                                   27
                                                                                  85
      SEP2=X12/SLEN
                                                                               CT
      IF (SEP.GT.SMIN) GO TO 2
                                                                               CT
                                                                                   29
      IF (SEP.LT. -SMIN) GO TO 34
                                                                               CT
                                                                                  30
      IF (SEP2.LE.SMIN) GO TO 34
                                                                               CT
                                                                                  31
      ICON1(I)=20000+IPX
                                                                               CT
                                                                                   32
      GO TO 20
                                                                               CT
                                                                                   33
      IF (SEP2.GT.SMIN) GO TO 3
                                                                               CT
      IF (SEP2.LT. -SMIN) GO TO 34
                                                                               CT
                                                                                   35
      ICUNS(1)=20000+1PX
                                                                               CT
      GU TU 7
                                                                               CT
                                                                                  37
      IF (1PY.EQ.0) GO TO 5
3
                                                                               CT
                                                                                  38
                                                                                   39
      SEP=YI1/SLEN
                                                                               CT
      SEP2=YIZ/SLEN
                                                                              CT
                                                                                   40
      IF (SEP.GT.SMIN) GO TO 4
                                                                               CT
                                                                                   41
      IF (SEP.LT. - SMIN) GO TO 34
IF (SEP2.LE. SMIN) GO TO 34
                                                                              CT
                                                                                   42
                                                                               CT
                                                                                  43
      ICUN1(1)=20000+1PY
                                                                              CT
      GO TO 20
                                                                              CT
                                                                                   45
      IF (SEP2.GT.SMIN) GO TO 5
                                                                              CT
                                                                                   46
      IF (SEPZ.LT. - SMIN) GO TO 34
                                                                              CT
                                                                                   47
      ICUN2(1)=20000+1PY
                                                                              CT
                                                                                  48
      GO TO 7
                                                                              CT
                                                                                   49
      1F (1PZ.EQ.0) GO TO 7
                                                                              CT
                                                                                   50
      SEP=ZII/SLEN
                                                                              CT
                                                                                   51
      SEPZ=ZIZ/SLEN
                                                                              CT
                                                                                  52
      IF (SEP.GT.SMIN) GO TO 6
                                                                              CT
                                                                                   53
      IF (SEP.LT. -SMIN) GO TO 34
                                                                              CT
                                                                                   54
      IF (SEP2.LE.SMIN) GO TO 34
                                                                              CT
                                                                                   55
      ICON1(I)=20000+IPZ
                                                                              CT
                                                                                   56
```

```
GO TO 20
                                                                              CT
                                                                                  57
      IF (SEP2.GT.SMIN) GO TO 7
                                                                              CT
                                                                                  58
      IF (SEP2.LT.-SMIN) GO TO 34
                                                                              CT
                                                                                  59
      ICDN2(1)=20000+1PZ
                                                                              CT
                                                                                  60
7
      IF (ICON1(I), NE. 0) GO TO 20
                                                                              CT
                                                                                  61
      DD 9 1C=1,N
                                                                              CT
                                                                                  62
      IF (IC.EQ. 1) GO TO 9
                                                                              CT
                                                                                  63
      ISEG=IC
                                                                              CT
                                                                                  64
      IF (ICONI(IC), NE. 0) GO TO 8
                                                                              CT
                                                                                  65
      SEP=(ABS(XI1-X(IC))+ABS(YI1-Y(IC))+ABS(ZI1-Z(IC)))/SLEN
                                                                              CT
                                                                                  66
      IF (SEP.LT.SMIN) GO TO 10
                                                                              CT
      IF (ICUNZ(IC).NE.0) GO TO 9
                                                                              CT
                                                                                  68
      SEP=(ABS(XI1-X2(IC))+ABS(YI1-Y2(IC))+ABS(ZI1-Z2(IC)))/SLEY
                                                                              CT
                                                                                  69
      IF (SEP.LT.SMIN) GO TO 15
                                                                              CT
                                                                                  70
      CONTINUE
                                                                              CT
                                                                                  71
      00 IN 50
                                                                              CT
      IF (ICON1(ISEG)) 12,11,13
                                                                              CT
10
                                                                                  73
      ICONI(I)=ISEG
                                                                              CT
11
                                                                                  74
      ICUNI(ISEG)=1
                                                                              CT
                                                                                  75
      GO TU 20
                                                                              CT
                                                                                  76
      ICUNI(I)=ICON1(ISEG)
15
                                                                              CT
                                                                                  77
      GO TO 20
                                                                              CT
                                                                                  78
      JNO=JNO-1
                                                                              CT
13
                                                                                  79
      ICUNI(I)=JNO
                                                                              CT
                                                                                  80
      IX=ICUNI(ISEG)
                                                                              CT
                                                                                  81
      ICON1 (ISEG)=JNO
                                                                              CT
                                                                                  82
      IF (ICONI(IX).EQ.ISEG) GO TO 14
                                                                              CT
                                                                                  83
      ICONZ(IX)=JNO
                                                                              CT
                                                                                  84
      GU TU 20
                                                                              CT
                                                                                  85
14
      ICON1(IX)=JNO
                                                                              CT
                                                                                  86
      GO 10 50
                                                                              CT
                                                                                  87
      IF (ICON2(ISEG)) 17,16,18
                                                                              CT
15
                                                                                  68
      ICONI(I)=ISEG
                                                                              CT
16
                                                                                  89
      ICONZ(ISEG)=I
                                                                              CT
                                                                                  90
      GO TO 20
                                                                              CT
                                                                                  91
      ICON1(I)=ICON2(ISEG)
17
                                                                              CT
                                                                                  95
      GO TO 20
                                                                              CT
                                                                                  93
      JNU=JNO-1
                                                                              CT
18
                                                                                  94
      ICONI(I)=JNO
                                                                              CT
                                                                                  95
                                                                              CT
      IX=ICONZ(ISEG)
                                                                                  96
      ICUNZ(ISEG)=JNO
                                                                              CT
                                                                                  97
                                                                              CT
      IF (ICON1(IX).EQ. ISEG) GO TO 19
                                                                                  98
      ICONZ(IX)=JNO
                                                                              CT
                                                                                 99
      GO TO 20
                                                                              CT 100
19
      ICUNI(IX)=JNO
                                                                              CT 101
CC
                                                                              CT 102
      DETERMINE CONNECTION DATA FOR END 2 OF SEGMENT.
                                                                              CT 103
                                                                              CT 104
20
      IF (ICON2(1), NE. 0) GO TO 33
                                                                              CT 105
      N.1=31 SS GO
                                                                              CT 106
      IF (IC.EQ. 1) GO TO 22
                                                                              CT 107
      ISEG=IC
                                                                              CT 108
      15 (1CUV1(1C). NE. 0) GO TO 21
                                                                              CT 109
      SEP=(ABS(XIZ-X(IC))+ABS(YIZ-Y(IC))+ABS(ZIZ-Z(IC)))/SLEN
                                                                              CT 110
      IF (SEP.LT.SMIN) GU TO 23
                                                                              CT 111
15
      IF (ICON2(IC), NE. 0) GO TO 22
                                                                              CT 112
      SEP=(ABS(XI2-X2(IC))+ABS(Y12-Y2(IC))+ABS(Z12-Z2(IC)))/SLEN
                                                                              CT 115
      IF (SEP.LT. SMIN) GO TO 28
                                                                              CT 114
      CONTINUE
                                                                              CT 115
55
                                                                              CT 116
      GO TO 33
```

```
CT 117
      IF (ICON1(18EG)) 25,24,26
23
                                                                                  CT 118
CT 119
24
       ICONZ(I)=ISEG
       ICONI (ISEG) = I
                                                                                  CT 120
       GO TO 33
                                                                                  C1 151
25
       ICON2(1)=ICON1(ISEG)
                                                                                  CT 122
       GO TU 33
26
       JN0=JN0-1
       100N2(1)=JNO
                                                                                  CT 124
                                                                                  CT 125
       IX=ICON1 (ISEG)
       ICUNI (ISEG) = JNO
       IF (ICONICIX), EQ, ISEG) GO TO 27
                                                                                  CT 127
                                                                                  CT 128
       ICONZ(IX)=JNO
       GO TO 33
                                                                                  CT 130
27
       ICONI(IX)=JNO
                                                                                  CT 131
       GO TO 33
                                                                                  CT 132
       IF (ICUN2(ISEG)) 30,29,31
28
                                                                                  CT 133
29
       ICON2(I)=ISEG
                                                                                  CT 134
       ICON2(ISEG)=I
                                                                                  CT 135
CT 136
       GO TO 33
       ICON2(I)=ICON2(ISEG)
30
                                                                                  CT 137
       GO TO 33
                                                                                  CT 138
CT 139
31
       JNO=JNO-1
       100NZ(1)=JNO
                                                                                  CT 140
       IX=ICONZ(ISEG)
                                                                                  CT 141
CT 142
       ICON2 (ISEG) = JNU
       IF (ICON1(IX).EQ. ISEG) GO TO 32
                                                                                  CT 143
       ICONS(IX)=JNO
       GO TO 33
                                                                                  CT 144
                                                                                  CT 145
CT 146
       ICONI(IX)=JNO
32
       CONTINUE
33
                                                                                  CT 147
       RETURN
       PRINT 35, 1
                                                                                  CT 148
34
                                                                                  CT 149
CT 150
       STOP
       FORMAT (1x, 7HSEGMENT, 14, 33H LIES IN OR BEHIND SYMMETRY PLANE)
35
                                                                                  CT 151
                                                                                  CT 152.
       END
```

```
SUBROUTINE CONSET
                                                                                CO
                                                                                CO
                                                                                     5
      CONSET COMPUTES INTERPOLATION CONSTANTS FOR USE IN EVALUATING
C
                                                                                CO
                                                                                     3
C
      THE FIELDS
                                                                                CO
C
                                                                                CO
                                                                                     5
      COMMON /DATA/ N,NP,X(200),Y(200),Z(200),SI(200),BI(200),ALP(200),
                                                                                CO
         BET(200), ICUN1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ
                                                                                     7
                                                                                CO
      COMMON /INTERP/ AT(3,200),8T(3,200),CT(3,200),ES(3),FS(3),GS(3),
                                                                                CO
                                                                                     8
        E(3), H(3)
                                                                                     9
      COMMON /ARRAX/ GI1, GI2, GI3, EC(200,5), EQ(200,5), IRET(200), BFR(15400 CO
                                                                                    10
                                                                                CO
                                                                                    11
      COMMON /SCOMP/ 5x(200), SY(200), 3Z(200)
                                                                                CO
                                                                                    12
      COMMON /CONST/ CUT, VEL, DT, NTSTEP
                                                                                CO
                                                                                    13
      00 5 I=1.N
                                                                                CO
                                                                                    14
      CALF=COS(ALP(I))
                                                                                CU
                                                                                    15
      SX(I)=CALF +CDS(BET(I))
                                                                                CO
                                                                                    16
      SY(I)=CALF +SIN(BET(I))
                                                                                    17
                                                                                CU
      SZ(I)=SIN(ALP(I))
                                                                                CO
                                                                                    18
      IM=ICON1(I)
                                                                                    19
                                                                                CO
      IP=ICONZ(I)
                                                                                CO
                                                                                    20
      IF (IM.GT.19000) IM=I
                                                                                CO
                                                                                    15
      IF (IP.GT.19000) IP=I
                                                                                CO
                                                                                    55
      S=91(I)
                                                                                CO
                                                                                    23
      IF (IM.EQ.0) GO TO 1
                                                                                CO
                                                                                    24
      DM=.5*(S+SI(IM))
                                                                                CO
                                                                                    25
      GO TO 2
                                                                                CO
                                                                                    26
                                                                                    27
      D4= ,5 + S
                                                                                CII
      IF (IP.EQ.0) GU TO 3
2
                                                                                CO
                                                                                    28
      DP=.5*(S+SI(IP))
                                                                                    29
                                                                                CO
      GO TO 4
                                                                                CO
                                                                                    30
3
      DP= . 5 * 8
                                                                                CO
                                                                                    31
      D1=DM*(DM+DP)
                                                                                CO
                                                                                    32
      DS=-DM+DP
                                                                                CO
                                                                                    33
      03=0P*(DM+DP)
                                                                                CO
                                                                                    34
      AT(1,1)=1,/D1
                                                                                CO
                                                                                    35
      SO1,1=(1,5)TA
                                                                                CO
                                                                                    36
      AT(3,1)=1./03
                                                                                CO
                                                                                    37
      BT(1,1)=-0P/01
                                                                                ÇO
                                                                                    38
      8T(2,1)=(0H-DP)/02
                                                                                    39
                                                                                CU
      BT(3,1)=DM/03
                                                                                CO
                                                                                    40
      CT(1, I) = 0.
                                                                                CU
                                                                                    41
      CT(2,1)=-0P*DM/02
                                                                                CO
                                                                                    42
5
      CT(3,1)=0.
                                                                                CU
                                                                                    43
      ES(1)=1./(2.*DT*DT)
                                                                                CO
                                                                                    44
      ES(2)=-2. *ES(1)
                                                                                CO
                                                                                    45
      ES(3)=ES(1)
                                                                                    46
                                                                                CO
      F3(3)=.5/DT
                                                                                CO
                                                                                    47
      FS(1) == FS(3)
                                                                                CO
                                                                                    48
      FS(2)=0.
                                                                                    49
                                                                                CO
      GS(1)=0.
                                                                                CO
                                                                                    50
      GS(2)=1.
                                                                                CO
                                                                                    51
      GS(3)=0.
                                                                                CO
                                                                                    52
      C2=1./(VEL . VEL)
                                                                                CO
                                                                                    53
      E(1)=E9(1)+C2
                                                                                CO
                                                                                    54
      E(2)=E3(2)*C2
                                                                                CO
                                                                                    55
      E(3)=ES(3) +C2
                                                                                CO
                                                                                    56
```

CS=-2./VEL	co	
H(1)=ES(1)+C2		57
	CO	58
H(2)=E3(2)*C2 H(3)=E3(3)*C2	CO	59
	CO	60
QI1=((ES(1)*DT/3.+.5*FS(1))*DT+GS(1))*DT QI2=((ES(2)*DT/3.+.5*FS(2))*DT+GS(2))*DT	CO	61
	CU	62
Q13=((ES(3)*DT/3.+.5*FS(3))*DT+GS(3))*DT RETURN	CO	63
	CO	64
END	co	65-

```
SUBROUTINE CONVRT
                                                                                   CV
C
                                                                                   CV
                                                                                         2
      CONVERT CHANGES GEOMETRY DATA FROM THE FORM STATING X,Y,Z COORDINATES OF EACH SEGMENT END TO X,Y,Z OF THE SEGMENT CENTER
C
                                                                                   CV
C
                                                                                   CV
C
       PLUS SEGMENT LENGTH AND ORIENTATION ANGLES AS REQUIRED IN MAIN
                                                                                   CV
      PROGRAM.
                                                                                   CV
                                                                                   CV
      COMMON /DATA/ N, NP, X(200), Y(200), Z(200), SI(200), BI(200), ALP(200),
                                                                                   CV
      1 BET(200), ICUN1(200), ICUN2(200), ITAG(200), IPX, IPY, IPZ
                                                                                   CV
                                                                                         9
       DIMENSION X2(1), Y2(1), Z2(1)
                                                                                   CV
                                                                                       10
       EQUIVALENCE (X2(1), SI(1)), (Y2(1), ALP(1)), (Z2(1), BET(1))
                                                                                   CV
                                                                                        11
       DO 1 I=1, N
                                                                                   CV
                                                                                        12
       XA=X(I)
                                                                                   CV
                                                                                       13
       YA=Y(I)
                                                                                   CV
                                                                                        14
       ZA=Z(I)
                                                                                   CV
                                                                                       15
      x8=x2(1)
                                                                                   CV
       48=45(I)
                                                                                   CV
                                                                                        17
                                                                                       18
       (I) SZ=8Z
                                                                                   CV
       X(I) = (XA + XB) * .5
                                                                                   CV
                                                                                       19
       Y(1)=(YA+YB)*,5
                                                                                    CY
                                                                                        20
       Z(1)=(ZA+ZB)*.5
                                                                                    CV
                                                                                        21
       AX-BXXA
                                                                                    CV
                                                                                       22
       YA=YB-YA
                                                                                   CV
                                                                                       23
       ZA= Z8 - ZA
                                                                                   CV
                                                                                        24
       SI(I)=SQRT(XA+XA+YA+YA+ZA+ZA)
                                                                                   CV
                                                                                       25
       ALP(I) = ASIN(ZA/31(I))
                                                                                   CV
                                                                                       26
                                                                                       27
       BET(I) = ATGN2(YA, XA)
                                                                                   CV
1
       RETURN
                                                                                   CV 28
       END
                                                                                   CV 29-
```

```
SUBROUTINE DATAGN
                                                                               DA
      DATAGN IS THE MAIN ROUTINE FOR INPUT OF GEOMETRY DATA.
                                                                                DA
C
                                                                                     3
C
                                                                                DA
      COMMON /DATA/ N,NP,X(200),Y(200),Z(200),SI(200),BI(200),ALP(200),
                                                                               DA
        BET(200), 1CUN1(200), 1CON2(200), 1TAG(200), 1PX, 1PY, 1PZ
                                                                                DA
      DIMENSION X2(1), Y2(1), Z2(1)
      DIMENSION ATST (4)
                                                                                DA
                                                                                     8
      INTEGER GM, ATST
                                                                                DA
      EQUIVALENCE (x2(1), SI(1)), (Y2(1), ALP(1)), (Z2(1), BET(1))
                                                                                DA
                                                                                   10
      DATA ATST/2HGW, 2HGS, 2HGE, 2HGM/
                                                                               DA
      DATA 14/,017453292/
                                                                                   12
      NWIRE=0
                                                                                DA
                                                                                   13
      N=0
                                                                                DA
                                                                                    14
      PRINT 8
                                                                                   15
                                                                               DA
      PRINT 9
                                                                                DA
C
                                                                                DA
                                                                                    17
                                                                                   18
      READ GEOMETRY DATA CARD AND BRANCH TO SECTION FOR OPERATION
                                                                               DA
C
C
      REQUESTED
                                                                                   19
C
                                                                               DA
                                                                                    20
      READ 10, GM, ITG, NS, XW1, YW1, ZW1, XW2, YW2, ZW2, RAD
                                                                               DA
                                                                                    21
      IF (GM.EQ.ATST(1)) GU TO 2
                                                                                   55
      IF (GM.EQ.ATST(2)) GO TO 3
                                                                               DA
                                                                                    53
      IF (GM.EQ.ATST(3)) GO TO 6
                                                                               DA
                                                                                    24
      IF (GM.EQ.ATST(4)) GO TO 5
                                                                               DA
                                                                                   25
      GO TO 7
                                                                               DA
                                                                                   26
                                                                               DA
C
                                                                                   27
      GENERATE SEGMENT DATA FOR STRAIGHT WIRE.
C
                                                                               DA
                                                                                    85
                                                                                   53
C
      NWIRE=NWIRE+1
                                                                               DA
2
                                                                                    30
      I1=N+1
                                                                               DA
                                                                                    31
      12=N+N9
                                                                               DA
                                                                                    32
      PRINT 11, NWIRE, XW1, YW1, ZW1, XW2, YW2, ZW2, RAD, NS, II, IZ, ITG
                                                                               DA
                                                                                   33
      CALL WIRE (XW1, YW1, ZW1, XW2, YW2, ZW2, RAD, NS, ITG)
                                                                               DA
                                                                                    34
      GO TO 1
                                                                               DA
                                                                                    35
C
                                                                                    36
      SCALE STRUCTURE DIMENSIONS BY FACTOR XWI.
C
                                                                               DA
                                                                                    37
C
                                                                               DA
                                                                                    38
      00 4 I=1, N
                                                                               DA
                                                                                   39
3
      X(I)=X(I)*X*1
                                                                               DA
                                                                                   40
      Y(1)=Y(1) + x w1
                                                                               DA
                                                                                    41
      Z(1)=Z(1) * X W1
                                                                               DA
                                                                                   42
      1*X*(I)5X=(I)5X
                                                                               DA
                                                                                   43
      1WX*(1)=YZ(1)*XW1
                                                                               DA
                                                                                   44
      Z2(I)=Z2(I) *X+1
                                                                               DA
                                                                                    45
      81(1)=81(1)*xw1
                                                                               DA
                                                                                   46
      PRINT 12, XM1
                                                                               DA
                                                                                   47
      GO TO 1
                                                                               DA
                                                                                    48
C
                                                                               DA
                                                                                    49
      MOVE STRUCTURE OR REPRODUCE ORIGINAL STRUCTURE IN NEW POSITIONS.
                                                                                   50
                                                                                   51
C
                                                                               DA
      PRINT 13, ITG, NS, XW1, YW1, ZW1, XW2, YW2, ZW2, RAD
                                                                               DA
                                                                                    55
                                                                                   53
      XW1 = XW1 + TA
                                                                               DA
      YW1=YW1*TA
                                                                               AC
                                                                                   54
      ZW1=ZW1 *TA
                                                                               DA
                                                                                    55
      CALL MOVE (XW1, YW1, ZW1, XW2, YW2, ZW2, INT(RAD+.5), NS, ITG)
                                                                               DA
                                                                                    56
```



```
GO TO 1
                                                                                               DA
                                                                                                     57
                                                                                               DA
       TERMINATE STRUCTURE GEOMETRY INPUT.
                                                                                                DA
                                                                                                     59
                                                                                                DA
                                                                                                     60
                                                                                                DA
       CALL CONECT
                                                                                                     61
       CALL CONVRT
                                                                                                DA
       RETURN
                                                                                                DA
                                                                                                     63
                                                                                                DA
7
       PRINT 14
                                                                                                     64
       PRINT 15, GM, ITG, NS, XM1, YM1, ZM1, XW2, YW2, ZW2, RAD
                                                                                                DA
       STOP
                                                                                                04
                                                                                                     66
                                                                                                DA
                                                                                                     67
       FORMAT (///, 33x, 35H- - - STRUCTURE SPECIFICATION - - -,//,37x, 28HCOORDINATES MUST BE INPUT IN,/,37x,
                                                                                                DA
                                                                                                     68
                                                                                                DA
                                                                                                     69
          29HMETERS OR BE SCALED TO METERS, /, 37X,
                                                                                                DA
                                                                                                     70
      3 31HBEFORE STRUCTURE INPUT IS ENDED, //)
FURMAT ( 2x,4HwIRE,79x,6HNO. UF,4x,5HFIRST,2x,4HLAST,5x,3HTAG,
                                                                                                     71
                                                                                                DA
                                                                                                DA
                                                                                                     72
      1 /,2x,3HNO.,6x,2Hx1,9x,2HY1,9x,2HZ1,10x,2HX2,9x,2HY2,9x,2HZ2,6x,
                                                                                                DA
                                                                                                     73
      2 6HRADIUS, 3x, 4HSEG., 5x, 4HSEG., 3x, 4HSEG., 5x, 3HND.)
                                                                                                DA
                                                                                                     74
10
       FURMAT (A2, 13, 15, 7F10.5)
                                                                                                DA
                                                                                                     75
       FORMAT (1x, 15, 3511, 5, 1x, 4511, 5, 2x, 15, 4x, 15, 1x, 15, 3x, 15)
FORMAT (6x, 26HSTRUCTURE SCALED BY FACTUR, F10, 5)
                                                                                                DA
                                                                                                     75
77
11
                                                                                                DA
12
13
        FORMAT (6x,49HTHE STRUCTURE HAS BEEN MOVED, MOVE DATA CARD IS -/
                                                                                                DA
                                                                                                     78
                                                                                                     79
       1 6x,13,15,7F10.5)
                                                                                                DA
       FORMAT (254 GEUMETRY DATA CARD ERROR)
FORMAT (1X,A2,13,15,7F10.5)
14
                                                                                                DA
                                                                                                     80
                                                                                                DA
                                                                                                     81
        END
                                                                                                DA
                                                                                                     82.
```

```
SUBROUTINE EINCF (T)
                                                                                            EI
                                                                                            EI
       EINCF IS CALLED AT EACH TIME STEP TO FILL ARRAY EINC WITH THE
                                                                                            EI
       APPLIED FIELD ON EACH SFGMENT AT TIME T. THIS ROUTINE USES A GAUSSIAN PULSE OF FORM EXP(-(A*+2)*(T-TMAX)**2) OR GENERAL TIME
                                                                                            EI
                                                                                            EI
                                                                                                  5
       DEPENDENCE FROM INPUT TABLE)
                                                                                            EI
                                                                                            EI
       COMMON /DATA/ N,NP,x(200),Y(200),Z(200),SI(200),BI(200),ALP(200), EI
            BET(200), ICON1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ
                                                                                            EI
       COMMON /SCOMP/ SX(200),SY(200),SZ(200)

COMMON /CONST/ COT, VEL, DT, NTSTEP

COMMON /CONST/ CINC(200),ESRC

COMMON /EINC/ EINC(200),ESRC

COMMON /ASURC/ EMAG(10),ISRC(10),NSRC

COMMON /ENSET/ A, TMAX, EIX, PX, PY, PZ, EX, EY, EZ, VLT(200), TH, IARB, TAMX EI
                                                                                                 10
                                                                                                 12
                                                                                                 13
               TA/0.017453292/, XW/0.1/
       DATA
                                                                                            EI
                                                                                                 15
       IF (NSRC.EW.O) GO TO 8
                                                                                            EI
                                                                                            EI
                                                                                                 17
       SET UP APPLIED FIELD FOR TRANSMITTING ANTENNA
                                                                                            EI
                                                                                                 18
C
                                                                                                 19
                                                                                            EI
       DO 1 1=1.N
                                                                                            EI
                                                                                                 20
       EINC(I)=0.
                                                                                            EI
       IF (IARB.NE.O) GU TO 2
                                                                                            EI
                                                                                                 25
       ESRC=A+(T-TMAX)
                                                                                            EI
                                                                                                 23
       ESRC=EXP(-ESRC+ESRC)
                                                                                            EI
       GO TO 6
                                                                                            EI
                                                                                                 25
                                                                                            EI
       TD=T
                                                                                                 26
       IF (TO.LT.O., OR, TO.GT. TAMX) GU TO 4
                                                                                            EI
                                                                                                 27
       ISETO/TW+1.5
                                                                                            EI
       IF (15.LT.2) 15=2
                                                                                            EI
                                                                                                 29
       IF (18.E9. 14HB) 18=15-1
                                                                                            EI
                                                                                                 30
       GO TO 5
                                                                                            EI
                                                                                                 31
       ESRC=0.
                                                                                            EI
                                                                                                 35
       RETURN
                                                                                            EI
       TO=TO-Th*FLOAT(IS-1)
                                                                                            EI
       ESRC=(.5+TD+((TD-TW)+VLT(IS-1)+(TD+TW)+VLT(IS+1))-(TD+TW)+(TD-TW)+ EI
                                                                                                 35
      IVLT(IS))/(TH+TH)
                                                                                            EI
                                                                                                 36
       IF (NSRC.EG.O) RETURN
                                                                                            EI
                                                                                                 37
       DO 7 IS=1, NSRC
                                                                                            EI
       I=ISRC(IS)
                                                                                            EI
                                                                                                 39
       EINC(I)=EMAG(IS)+ESRC
                                                                                            EI
                                                                                                 40
       RETURN
                                                                                                 41
                                                                                            EI
                                                                                            EI
                                                                                                 42
       SET UP APPLIED FIELD FOR INCIDENT PLANE WAVE
                                                                                            EI
                                                                                                 43
                                                                                            EI
                                                                                                 44
       TCUNET-EIX
                                                                                            EI
                                                                                                 45
                                                                                            EI
       00 13 1=1.N
                                                                                                 46
       TD=TCON-(x(1)+Px+Y(1)+PY+Z(1)+PZ)
                                                                                            EI
                                                                                                 47
       IF (IARB. VE. 0) GO TO 9
                                                                                           EI
                                                                                                 48
       A+GT=OT
                                                                                            EI
                                                                                                 49
       ESACAEXP(-TO+TO)
                                                                                           έI
                                                                                                 50
       GO TO 12
                                                                                           EI
       IF (TO.LT.O..OR.TD.GT.TAMX) GO TO 10
                                                                                           EI
                                                                                           FI
       15=TD/T#+1.5
                                                                                                 53
       IF (15.LT.2) 15=2
                                                                                            EI
                                                                                                 54
       1F (15.EQ, 1488) 13=13-1
                                                                                                55
                                                                                           EI
       GO TO 11
                                                                                                 56
```

```
10
      EINC(I)=0.
                                                                               EI
      GO TO 15
                                                                               EI
                                                                                   58
11
      TO=TO-THAFLOAT(IS-1)
                                                                                   59
                                                                               EI
      ESRC=(,5*TD+((TD-TH)*VLT(IS-1)+(TD+TW)*VLT(IS+1))*(TD+TW)*(TD-TW)*
                                                                               EI
                                                                                    60
     IVLT(IS))/(THeTa)
                                                                               EI
                                                                                   61
12
      £INC(1)=ESHC*(SX(1)*EX+SY(1)*EY+SZ(1)*EZ)
                                                                                   62
      CUNTINUE
                                                                               EI
                                                                                   63
      TO=TCON
                                                                               EI
                                                                                   64
      IF (1ARB, NE. 0) GO TO 3
                                                                               EI
                                                                                   65
      ESHC=A+TCON
                                                                               EI
                                                                                   66
      ESRC=EXP(-ESRC +ESRC)
                                                                               EI
                                                                                   67
      RETURN
                                                                               EI
                                                                                   68
      ENTRY
               ESET(T)
                                                                               EI
                                                                                   69
C
                                                                               EI
                                                                                   70
                                                                                   71
      READ DATA CARDS AND INITIALIZE CONSTANTS FOR EXCITATION
                                                                               EI
                                                                               EI
                                                                                   72
      READ 25. IARB, NSRC, TW, THET, PHI, ET, RZERO, TMAX
                                                                               EI
                                                                                    73
      PRINT 31, IARB, NSRC, TW, THET, PHI, ET, RZERO, TMAX
                                                                                   74
                                                                               EI
      PRINT 26
                                                                               EI
                                                                                   75
      IF (IARB.NE.0) GO TO 15
                                                                               EI
                                                                                   76
      A=SQRT(-ALUG(XM))/(THA.5)
                                                                                   77
                                                                               EI
      IF (TMAX.GT.1.E-20) GU TO 14
                                                                               EI
                                                                                   78
                                                                               EI
                                                                                   79
      EIN=0.03
      IF (TMAX, LT, (-1, E-20)) EIN=-TMAX
                                                                               EI
                                                                                   80
      TMAX=SORT (-ALOG(EIN))/A
                                                                               EI
                                                                                   81
      TMAX=(AINT(TMAX/DT)+1.)+DT
                                                                               EI
                                                                                   82
      EIX=EXP(-A+A+TMAX+TMAX)+100.
                                                                               EI
                                                                                   83
      PRINT 27, A, TMAX, EIX
                                                                                   84
                                                                               EI
      GO TO 17
                                                                               EI
                                                                                   85
15
      IF (1498.GT.200) GO TO 20
                                                                               EI
                                                                                   86
      TAMX=TW+FLUAT(IARB-1)
                                                                               EI
                                                                                   87
      READ 21, (VLT(I), I=1, IARB)
                                                                               EI
                                                                                   88
      PRINT 23
                                                                                   89
                                                                               EI
      T==TH
                                                                               EI
                                                                                   90
      DO 16 1=1, TARB
                                                                               EI
                                                                                   91
      T=T+TW
                                                                               EI
                                                                                   92
                                                                               EI
16
      PRINT 22, I,T,VLT(I)
                                                                                   93
      TMAXEO.
                                                                               EI
                                                                                   94
      IF (NSRC.EQ.0) GO TO 19
                                                                                   95
17
                                                                               EI
                                                                                   96
      PRINT 28
                                                                               EI
      DO 18 15=1, NSRC
                                                                               EI
                                                                                   97
      READ 29, ITG, II, VMAG
                                                                               EI
                                                                                   98
      I=ISEGNO(ITG, II)
                                                                               EI
                                                                                   99
      PRINT 30, IS, ITG, II, I, VMAG
                                                                               EI 100
      ISRC(IS)=I
                                                                               EI 101
      EMAG(IS)=VMAG/SI(I)
                                                                               EI 102
18
      RETURN
                                                                               EI 103
19
      PRINT 32, RZERO, THET, PHI, ET
                                                                               EI 104
      THE TETHETATA
                                                                               EI 105
      PHI=PHI+T4
                                                                               EI 106
                                                                               EI 107
      ET=ET+TA
      ST=SIN(THET)
                                                                               EI 108
      CT=COS(THET)
                                                                               EI 109
      SPESIN(PHT)
                                                                               EI 110
      CP=CUS(PHI)
                                                                               EI 111
                                                                               EI 112
      SE=SIN(ET)
      CE=CUS(ET)
                                                                               EI 113
                                                                               EI 114
EI 115
      PX=-ST+CP/VEL
      PY=-ST+SP/VEL
      PZ=-CT/VEL
```

```
EX=CT+CP+CE-SP+SE
                                                                                          E1 117
       EYECT+SP+CL+CP+SE
                                                                                           EI 118
       EZ=-ST+CE
                                                                                           EI 119
       EIX=TMAX+RZERO/VEL
                                                                                           EI 120
       RETURN
                                                                                           E1 121
       PRINT 24
                                                                                           E1 122
20
       STUP
                                                                                           EI 123
C
                                                                                           EI 124
51
                                                                                           EI 125
       FORMAT (6612.5)

FORMAT (30x,15,613.5,614.5)

FORMAT ( 31x,52HTIME DEPENDENCE - GENERAL, SET BY INPUT TABLE B EI
                                                                                           EI 126
22
                                                                                           EI 127
53
                                                                                              128
      1ELOW. //, 31x, 4HSTEP, 7x, 4HTIME, 9x, 6HSOURCE, /, 32x, 3HNO., 6x, 6H(SEC.), EI 129
                                                                                           EI 130
         7x, 8HSTRENGTH)
       FORMAT (52H NUMBER OF EXCITATION VALUES EXCEEDS ARRAY DIMENSION)
24
                                                                                           EI
                                                                                              131
25
       FORMAT (215,6E10,3)
                                                                                           E1 132
       FORMAT ( //, 38x, 26H- - - EXCITATION - - - -,//)
FORMAT ( 31x, 78HTIME DEPENDENCE- GAUSSIAN, PEAK AT TIME=TMAX - -
                                                                                           EI 133
26
                                                                                           EI
                                                                                              134
      1 EXP(-(A++2)+(TIME-TMAX)++2),//,31X,2HA=,E12,5,9H, TMAX=,E12,5, E1 135
      2 //,31x,10HSOURCE HAS, F8.3,33H PERCENT OF PEAK VALUE AT TIME=0.)
FORMAT ( //,31x,17HVOLTAGE SOURCES =,//,31x,23HSOURCE SOURCE SEG
1HENT, 6x,12HPEAK VOLTAGE,/,33x,3HNO.,4x,3HTAG,2x,4HINC.,2x,4HSEG.,
                                                                                           EI 136
28
                                                                                          EI 137
                                                                                           EI 138
      2 8x,7H(VOLTS),/,40x,3HNU.,9X,3HNU.)
                                                                                           EI 139
       FORMAT (215,E10.3)
FORMAT (31X,15,17,
29
                                                                                           EI 140
                 (31x,15,17,216,5x,F10.4)
30
                                                                                           EI 141
       FORMAT ( //,1x,26H*** EXCITATION DATA CARD**,215,E12.5,4F10.5,E12 E1 142
31
      1.5)
                                                                                           EI 143
       FORMAT ( //,31x,22HINCIDENT PLANE PULSE -,/,31x,65HAT TIME = 0. L
                                                                                           EI
                                                                                              144
      1EADING EDGE OF PULSE IS SHIFTED BACK FROM ORIGIN BY,F10.5,7H HETER EI 145
      29, //. 31x, 26HINCIDENCE ANGLES - THETA=. F10,5.5H DEG., /. 51x.6HPHI
                                                                                          EI 146
      3 =.F10.5,5H DEG.,/,51x,6HETA =,F10.5,5H DEG.,/)
                                                                                           EI 147
       END
                                                                                           EI 148-
```

```
SUBROUTINE EMAT (RX, HY, RZ, RZ, TAU, SXJ, SYJ, SZJ, J)
                                                                                    EH
                                                                                    EM
       EMAT COMPUTES THE COEFFICIENTS WHICH MULTIPLY A 3 SEGMENT BY 3 TIME STEP PATCH OF CURRENT AND INTEGRAL OF CURRENT TO YIELD THE
                                                                                    EM
                                                                                    EM
       VECTOR COMPONENTS OF ELECTRIC FIELD
                                                                                    EM
       CDMMUN /DATA/ N,NP,X(200),Y(200),Z(200),SI(200),BI(200),ALP(200),
                                                                                    EM
           BET(200), ICON1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ
                                                                                    EM
       CUMMUN /INTERP/ AT(3,200), BT(3,200), CT(3,200), ES(3), FS(3), GS(3),
                                                                                  EM
           E(3), H(3)
                                                                                    EM
                                                                                        10
       CUMMON /INTG/
                       x1,x2,x3,x4,x5,x6,x7,x8,x9,x10,x11,x12
       COMMON /EMATS/ EMX(3,3), EMY(3,3), EMZ(3,3), QMX(3,3), QMY(3,3), GMZ(3 EM
      1.3)
                                                                                    EM
                                                                                        13
       COMMON /CONST/ CDT, VEL, DT, NTSTEP
                                                                                    EM
                                                                                         14
       DIMENSION P(3), G(3), F(3)
                                                                                    EM
                                                                                        15
       DO 1 L=1.3
                                                                                    EM
                                                                                        16
       P(L)=2. *ES(L) *TAU+FS(L)
                                                                                    EH
                                                                                         17
       G(L)=(ES(L)*TAU+FS(L))*TAU+GS(L)
                                                                                    EM
                                                                                        18
       F(L)==P(L)/VEL
                                                                                    EM
                                                                                        19
       BCON=-2.*(HX*SXJ+RY*SYJ+RZ*SZJ)
                                                                                    EM
                                                                                        20
       CCUN=R2+BI(J)*BI(J)
                                                                                    EM
                                                                                        21
       3J=S1(J)
                                                                                    EM
                                                                                        25
       CALL INTEG (SJ, BCON, CCON)
DO 2 L=1,3
                                                                                    EM
                                                                                        23
                                                                                    EM
                                                                                        24
       AL=AT(L,J)
                                                                                    EM
                                                                                        25
       BL=BT(L,J)
                                                                                    EM
                                                                                        26
       CL=CT(L,J)
                                                                                    EM
                                                                                        27
       DO 2 M=1,3
                                                                                    EM
                                                                                        85
       EM=E(M)
                                                                                    EM
                                                                                        29
                                                                                        30
       FM=F(M)
                                                                                    EM
       GM=G(M)
                                                                                    EM
                                                                                         31
       T1=H(M)*(AL*X9+CL*X1)+P(H)*(AL*X10+BL*X6+CL*X2)
                                                                                    EM
       T2=2, *AL*(FM*X6+GM*X7)+BL*(EM*X1+FM*X2+GM*X3)
                                                                                    EM
                                                                                        33
       T3=2, *AL * (EM * X9+FM * X10+GM * X11) +BL * (FM * X6+GM * X7)
                                                                                    EM
                                                                                         34
       T4=2. *AL * (EM * X6+FM * X7+GM * X8)+BL * (EM * X2+FM * X3+GM * X4)
                                                                                    EM
                                                                                        35
       T5=2.*AL*(LM*X10+FM*X11+GM*X12)+8L*(EM*X6+FM*X7+GM*X8)
                                                                                    EM
                                                                                        36
       T1=-(T1-VEL+T3)+1.E-7
                                                                                    EM
                                                                                        37
       T2=-YEL+T2+1.E-7
                                                                                    EM
                                                                                        38
                                                                                    EM
                                                                                        39
       COEFFICIENTS FUR CURRENTS
                                                                                    EM
                                                                                        40
                                                                                    EM
                                                                                        41
       EMX(L,M)=SXJ+T1+RX+T2
       EMY(L,M)=SYJ+T1+RY+T2
                                                                                    EH
                                                                                        43
       EMZ(L,M)=SZJ+T1+RZ+T2
                                                                                    EM
                                                                                        44
       14=-VEL +VEL +T4+1.E-7
                                                                                        45
                                                                                    EM
       T5=VEL + VEL + T5 + 1 . E = 7
                                                                                    EM
                                                                                        46
                                                                                    EH
                                                                                        47
      COEFFICIENTS FOR TIME INTEGRAL OF CURRENTS
                                                                                    EM
                                                                                        48
                                                                                    EM
                                                                                        49
       QMX(L,M)=RX+T4+5XJ+T5
                                                                                    EM
                                                                                        50
       6MY(L,M)=#Y+14+5YJ+15
                                                                                    EM
                                                                                        51
       QMZ(L, M)=RZ+T4+SZJ+T5
                                                                                        52
2
       RETURN
                                                                                    EM
                                                                                        53
      ENU
```

```
SUBROUTINE FACIO (A, AR, N, IX, IP)
                                                                                FO
                                                                                FO
      3/R WHICH CONTROLS I/O FOR FACTORIZATION
                                                                                 FO
                                                                                      3
C
                                                                                 FO
      COMMON /MATPAR/ NBLOKS, NPBLK, NLAST, INT
                                                                                 FO
                                                                                      5
      DIMENSION A(N,N), IP(N), IX(N), AR(1)
                                                                                 FO
      IF (NBLOKS.GT.2) GO TO 1
                                                                                 FO
      CALL FACTR (N,A, IP, N)
                                                                                FO
      RETURN
                                                                                FO
                                                                                      9
      REMIND 11
                                                                                FO
                                                                                    10
      REWIND 13
REWIND 14
                                                                                FO
                                                                                 FO
                                                                                     12
      ITENPBLK .N
                                                                                FO
                                                                                     13
      11=1
                                                                                FU
      S=OHII
                                                                                FO
                                                                                     15
      11=51
                                                                                FO
                                                                                     16
      13=12+1
                                                                                 FO
                                                                                     17
                                                                                 FO
      14=2+11
                                                                                     18
C
                                                                                 FU
                                                                                     19
      BUFFER IN BLOCKS AND BLOCKS FROM TAPE $
                                                                                 FU
                                                                                     20
                                                                                FU
                                                                                     15
      READ (13) (AR(I), I=I1, I2)
                                                                                 FU
                                                                                     22
      READ (13) (AR(1), 1=13,14)
                                                                                 FU
                                                                                     23
      CALL LFACTR (A,N,1,2,IP)
                                                                                 FO
                                                                                     24
                                                                                FO
                                                                                     25
      BUFFER OUT BLOCK! TO TAPEZ (BLOCK! FACTORED)
                                                                                FO
                                                                                     26
                                                                                FO
C
                                                                                     27
      WRITE (11) (AR(I), I=I1, I2)
                                                                                FU
                                                                                FO
                                                                                     29
      BUFFER OUT BLOCKS TO FILES
                                                                                FU
                                                                                     30
                                                                                FO
                                                                                     31
      WRITE (14) (AR(I), I=13,14)
                                                                                FO
      DO S IXBLKS=3, NBLOKS
                                                                                FO
                                                                                     33
                                                                                FO
C
                                                                                     34
      BUFFER IN BLOCKS FROM TAPES
                                                                                FU
                                                                                     35
                                                                                FO
                                                                                    36
                                                                                FO
      HEAD (13) (AR(1), 1=13,14)
      CALL LFACTR (A,N,1,1xBLK2,1P)
                                                                                FO
C
                                                                                FO
                                                                                     39
      BUFFER OUT BLOCKS TO FILES
                                                                                FO
                                                                                     40
                                                                                FU
                                                                                    41
C
      WRITE (14) (AR(I), 1=13,14)
                                                                                FO
                                                                                     42
      CONTINUE
                                                                                FU
                                                                                     43
                                                                                FO
      IXBLK1=1
                                                                                     44
      IXELKI=IXBLK1+1
                                                                                FU
                                                                                     45
                                                                                     46
      IXBLK2=IXBLK1+1
                                                                                FO
                                                                                FO
                                                                                     47
      WITH THE EXCEPTION OF THE FIRST PASS, IFILES BECOMES IFILE4 AND VI FO
                                                                                FU
                                                                                    49
      IFILE3=13
                                                                                FO
                                                                                     50
                                                                                    51
      IFILE 4=14
                                                                                FU
      IF (2+(IXBLK1/2).NE.IXBLK1) GO TO 4
                                                                                FO
                                                                                    25
                                                                                    53
      IFILE3=14
                                                                                FO
                                                                                FU
      IFILE 4=13
                                                                                    54
      REWIND IFILES
REWIND IFILES
                                                                                    55
                                                                                SU
                                                                                     56
```

```
57
58
CCC
      BUFFER IN BLOCK! AND BLOCKS FROM IFILES
                                                                               FO
                                                                               FU
                                                                                   59
      READ (IFILE3) (AR(1), I=11, 12)
                                                                                   60
      READ (IFILE3) (AR(1), 1=13,14)
                                                                               FU
                                                                                   61
      CALL LFACTR (A, N, IXBLK1, IXBLK2, IP)
                                                                               FU
                                                                                   62
                                                                               FO
                                                                                   63
      BUFFER OUT BLUCK! TO TAPER (BLUCK! FACTORED)
                                                                               FU
                                                                                    64
C
                                                                               FO
                                                                                   65
      WRITE (11) (AR(I), I=I1, 12)
                                                                               FO
                                                                                   66
C
                                                                                   67
                                                                               FO
CC
      BUFFER OUT BLOCKS TO IFILE4
                                                                               F()
                                                                                   68
                                                                               FO
                                                                                   69
                                                                                   70
      WRITE (IFILE4) (AR(1), 1=13,14)
                                                                               FO
      IF (IXBLK2. NE. NBLUKS) GO TO 5
                                                                               FU
                                                                                   72
      BUFFER OUT BLOCKS TO TAPES (BLOCKS FACTORED -- FACTORIZATION FINISHE FO
                                                                                   73
C
                                                                               FO
                                                                                    74
      WRITE (11) (AR(I), I=13,14)
                                                                                   75
      REWIND 11
                                                                               FO
                                                                                   76
      REWIND
               13
                                                                               FO
                                                                                   77
      REWIND 14
                                                                                   78
                                                                               FO
      GO TO 6
                                                                               FO
                                                                                   79
      IXBLK2=IXBLK2+1
                                                                               FO
5
                                                                                   80
      IF (IXBLKZ.GT. NBLUKS) GO TO 3
                                                                               FO
                                                                                   81
                                                                               FO
                                                                                   82
      BUFFER IN BLOCK2 FROM IFILES
                                                                               FO
                                                                                   83
                                                                               FU
                                                                                   84
      READ (IFILE3) (AR(1), 1=13,14)
                                                                               FO
                                                                                   85
      CALL LFACTR (A, N, IXBLK1, IXBLK2, IP)
                                                                               FO
                                                                                   86
CC
                                                                               FO
                                                                                   87
      BUFFER OUT BLOCKS TO FILE4
                                                                               FU
                                                                                   88
                                                                               FU
                                                                                   89
                                                                               FO
                                                                                   90
      WRITE (IFILE4) (AR(I), 1=13, 14)
                                                                               FO
      GO TO 5
                                                                                   91
      CALL LUNSCR (A, AR, N, IX, IP)
                                                                               FO
                                                                                   92
      RETURN
                                                                               FU
                                                                                   93
      END
                                                                                   94-
```

```
SUBROUTINE FACTR (N,A,P,NDIM)
C
                                                                                              2
       SUBROUTINE TO FACTOR A MATRIX INTO A UNIT LOWER TRIANGULAR MATRIX
000000
                                                                                       FA
       AND AN UPPER TRIANGULAR MATRIX USING THE GAUSS-DOOLITTLE ALGURITHM FA PRESENTED ON PAGES 411-416 OF A. RALSTON--A FIRST COUNSE IN FA
       NUMERICAL ANALYSIS. COMMENTS BELOW REFER TO COMMENTS IN HALSTONS TEST. (MATRIX TRANSPOSED)
                                                                                        FA
       TEST.
                                                                                        FA
                                                                                              7
                                                                                        FA
       DIMENSION A(NDIM, NDIM), P(NDIM)
                                                                                        FA
       COMMON /SCHATM/ D(200)
                                                                                        FA
                                                                                             10
       INTEGER R,P,RM1,RP1,PJ,PR
                                                                                        FA
                                                                                            11
       IFLG=0
                                                                                       FA
                                                                                            12
       DU 9 R=1, N
                                                                                        PA
                                                                                            13
                                                                                        FA
                                                                                            14
       STEP 1
CC
                                                                                        FA
                                                                                            15
                                                                                            16
       DO 1 K=1,N
                                                                                        FA
                                                                                             17
       D(K)=A(R,K)
                                                                                        FA
                                                                                            18
1
       CONTINUE
                                                                                            19
                                                                                        FA
CCC
                                                                                            20
                                                                                            21
       STEPS 2 AND 3
                                                                                        FA
                                                                                        FA
                                                                                            25
       RM1=R-1
                                                                                        FA
                                                                                            53
       IF (RM1.LT.1) GO TO 4
                                                                                        FA
                                                                                            24
       DO 3 JE1, RM1
                                                                                        FA
                                                                                            25
       PJ=P(J)
                                                                                        FA
                                                                                            26
       A(R, J)=0(PJ)
                                                                                       FA
                                                                                            27
       D(PJ)=D(J)
                                                                                       FA
                                                                                            28
       JP1=J+1
                                                                                       FA
                                                                                            29
       00 2 I=JP1,N
                                                                                       FA
                                                                                            30
       D(1)=D(1)-A(J,1)+A(R,J)
                                                                                       FA
                                                                                            31
                                                                                       FA
2
       CONTINUE
                                                                                            25
       CONTINUE
                                                                                       FA
                                                                                            33
34000
       CONTINUE
                                                                                       FA
                                                                                            34
                                                                                       FA
                                                                                            35
       STEP 4
                                                                                       FA
                                                                                            36
                                                                                       FA
                                                                                            37
       DMAX:ARS(D(R))
                                                                                       FA
       P(R) aR
                                                                                       FA
                                                                                            39
                                                                                       FA
       RP1=R+1
                                                                                            40
       IF (RP1.GT.N) GO TO 6
                                                                                       FA
                                                                                            41
                                                                                       FA
       DO 5 1=RP1,N
                                                                                            42
       ELMAG=ABS(D(I))
                                                                                       FA
                                                                                            43
                                                                                       FA
       IF (ELMAG.LT.DMAX) GO TO 5
                                                                                            44
       DMAX=ELMAG
                                                                                       FA
                                                                                            45
                                                                                       FA
       P(R)=I
                                                                                            46
                                                                                       FA
5
       CONTINUE
                                                                                            47
       CONTINUE
                                                                                       FA
6
                                                                                            48
       IF (DMAX.LT.1.E-10) IFLG=1
                                                                                       FA
                                                                                            49
       PREP(R)
                                                                                       FA
                                                                                            50
       A(R,R)=D(PR)
                                                                                       FA
                                                                                            51
                                                                                       FA
       D(PR)=0(R)
                                                                                            52
                                                                                       FA
                                                                                            53
C
                                                                                       FA
       STEP 5
                                                                                            54
C
                                                                                       FA
                                                                                            55
       IF (RP1.GT.N) GO TO 8
                                                                                       FA
                                                                                            56
```

	AA DOL N	FA	57
	00 7 1=RP1,N	FA	58
	A(R, 1)=U(1)/A(R,R)	6.	59
7	CONTINUE		
8	CONTINUE	FA	60
•	IF (IFLG.E0.0) GO TO 9	FA	61
	PRINT 10, R, DMAX	FA	62
		FA	63
	IFLG=0		64
9	CONTINUE		-
	RETURN	FA	65
		FA	66
C		The state of the s	67
10	FORMAT (1x,6HPIVOT(,13,2H)=,£16.8)		44-
	END		00-

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	SUBROUTINE FOLOCK (NELOKS, NPBLK, NLAST, IMAX, N, INT)	FB	1
C		FB	2
C	FBLOCK DETERMINES BLOCK SIZE AND NUMBER OF BLOCKS WHEN OUT-OF-CORE	FB	3
C	MATRIX STORAGE IS RECUIRED. INT=O FETURNED IF MATRIX FITS IN CORE	FB	4
C		FB	5
	IF (N+N.LE.IMAX) GO TO 1	FB	6
	NPBLK=IMAX/(2*N)	FB	7
	IF (NPSLK.LT.1) STOP	FB	8
	1×T=1	FB	9
	NBLOKS=(N-1)/NPBLK+1	FB	10
	NLAST=N-(NBLOKS-1)*NPBLK	FB	11
	PRINT 2. NELOKS, NPBLK, NLAST	FB	12
	RETURN	FB	13
1	NBLOK9=2	FB	14
	NPBLK=(N+1)/2	FB	15
	NLAST=N-NPBLK	FB	16
	1NT=0	FB	17
	RETURN	FB	18
C		FB	19
2	FORMAT (1x,11m BLOCKING ,415/)	FB	20
	END	FB	21-

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```
SUBROUTINE FORT (A,M,S, IFS, IFERR)
                                                                                           FT
       FOURIER TRANSFORM SUBROUTINE, PROGRAMMED IN SYSTEM/360,
       BASIC PROGRAMMING SUPPORT, FORTRAN IV. FURM C28-6504
       THIS DECK SET UP FOR IBSYS ON IBM 7094.
                                                                                           FT
       DOES EITHER FOURIER SYNTHESIS, I.E., COMPUTES COMPLEX FOURIER SERIES FT
       GIVEN A VECTOR OF N COMPLEX FOUNTER AMPLITUDES, OR, GIVEN A VECTOR FT OF COMPLEX DATA X DOES FOURTER ANALYSIS, COMPUTING AMPLITUDES.
       A IS A COMPLEX VECTOR OF LENGTH N=2**M CUMPLEX NOS. OR 2*N REAL
                                                                                                10
       NUMBERS. A IS TO HE SET BY USER.
                                                                                                11
       M 18 AN INTEGER O.LT.M.LE.13, SET BY USER.
8 IS A VECTOR S(J) = SIN(2*PI*J/NP), J=1,2,...,NP/4-1,
                                                                                                12
                                                                                                13
       COMPUTED BY PRUGRAM.
                                                                                                14
       IFS 1S A PARAMETER TO BE SET BY USER AS FOLLOWS-
IFS=0 TO SET NP=2**M AND SET UP SINE TABLE.
                                                                                                15
       IFS=1 TO SET NEWP=2**M, SET UP SIN TABLE, AND DO FOURIER
                                                                                                17
       SYNTHESIS, REPLACING THE VECTOR A BY
                                                                                                18
                                                                                                19
       x(J)= SUM OVER K=0, N-1 OF A(K) *EXP(2*PI+I/N) ** (J*K),
                                                                                                20
       J=0, N-1, WHERE I=SORT(-1)
                                                                                           FT
                                                                                                21
C
                                                                                                55
       THE X'S ARE STORED WITH HE X(J) IN CELL 2+J+1
                                                                                                57
       AND IM X(J) IN CELL 2*J+2 FOR J=0,1,2,...,N-1. THE A'S ARE STORED IN THE SAME MANNER.
                                                                                           FT
                                                                                                25
                                                                                                26
                  TO SET N=NP=2**M. SET UP SIN TABLE. AND DO FOURIER
       ANALYSIS, TAKING THE INPUT VECTOR A AS X AND
                                                                                           FT
       REPLACING IT BY THE A SATISFYING THE ABOVE FOURIER SERIES.
                                                                                                29
       IFS=+2 TO DO FOURIER SYNTHESIS ONLY, WITH A PRE-COMPUTED S.
                                                                                                30
       IFS=-2 TO DO FUURIER ANALYSIS ONLY, WITH A PRE-COMPUTED S.
                                                                                                31
       IFERR IS SET BY PROGRAM TO-
                                                                                           FT
                                                                                                32
       =0 IF NO ERROR DETECTED.
                                                                                           FT
                                                                                                33
       =1 IF M IS OUT OF HANGE., UR, WHEN IFS=+2,-2, THE
                                                                                                34
       PRE-COMPUTED S TABLE IS NOT LANGE ENDUGH.
                                                                                           FT
                                                                                                35
       =-1 WHEN IFS =+1,-1, MEANS UNE IS RECUMPUTING S TABLE
                                                                                                35
       UNNECESSARILY.
                                                                                                37
                                                                                                38
       NOTE- 48 STATED ABOVE, THE MAXIMUM VALUE OF M FOR THIS PROGRAM ON THE IBM 7094 IS 13. FUR 360 MACHINES HAVING GREATER STORAGE
                                                                                                39
                                                                                           FT
                                                                                                40
       CAPACITY, ONE MAY INCHEASE THIS LIMIT BY REPLACING 13 IN
                                                                                                41
       STATEMENT 3 RELOW MY LOGS N. WHERE N 19 THE MAX, NO. UF
                                                                                           FT
                                                                                                42
       COMPLEX NUMBERS ONE CAN STORE IN HIGH-SPEED CORE. ONE MUST ALSO ADD MORE DO STATEMENTS TO THE BINARY SORT ROUTINE
                                                                                           FT
                                                                                                43
                                                                                                44
       FOLLOWING STATEMENT 24 AND CHANGE THE EQUIVALENCE STATEMENTS
                                                                                                45
       FOR THE K'S.
                                                                                                46
                                                                                           FT
                                                                                                47
       DIMENSION 4(1), 5(1), K(14)
                                                                                                48
       EQUIVALENCE (K(13),K1), (K(12),K2), (K(11),K3), (K(10),K4)
EQUIVALENCE (K(9),K5), (K(8),K6), (K(7),K7), (K(6),KR)
EQUIVALENCE (K(5),K9), (K(4),K10), (K(3),K11), (K(2),K12)
                                                                                          FT
                                                                                                49
                                                                                           FT
                                                                                                50
                                                                                                51
       EQUIVALENCE (K(1), K13), (K(1), N2)
       1 (4) 2,2,1
                                                                                                53
       IF (M-13) 4,4,2
                                                                                                54
       IFERHO1
                                                                                                55
       RETURN
```

## BEST AVAILABLE COPY

4	IFERR=0	FT 5	57
	N=2aam		
			8
	IF (1485(1FS)-1) 25,25,5	_	9
C	WE ARE DOING THANSFORM ONLY. SEE IF PRE-COMPUTED		0
C	S TABLE IS SUFFICIENTLY LARGE	FT 6	1
5	IF (N-NP) 7,7,6	FT 6	2
6	IFERR=1	FT 6	3
	GU TO 25		4
C	SCHAMPLE A, BY SANDE'S METHOD		5
7	K(1)=2*N		
'			6
	M,5=1 8 CD		7
8	K(L)=K(L-1)/5		8
	DO 9 L=M,12		9
9	K(L+1)=2	FT 7	0
C	NOTE EQUIVALENCE OF KL AND K(14-L)	FT 7	1
C	BINARY SURT-	FT 7	2
	IJ=2	FT 7	3
	00 11 J1=2,K1,2	FT 7	4
	DO 11 J2=J1, K2, K1		5
	00 11 35=32,45,42		6
	DO 11 J4=J3, K4, K3		
			7
	DO 11 J5=J4,K5,K4		8
	DO 11 Jo=J5, K6, K5		9
	00 11 J7=J6,K7,K6		0
	00 11 J8=J7, K8, K7		1
	DO 11 J9=J8,K9,K8	FT 8	15
	DO 11 J10=J9,K10,K9	FT 8	3
	DO 11 J11=J10,K11,K10	FT 8	4
	DO 11 J12=J11,K12,K11	FT 8	5
	DO 11 JI=J12,K13,K12		16
	IF (IJ-JI) 10,11,11		7
• •			88
10	1=A(IJ-1)		
	A(IJ-I)=A(JI-I)		19
	A(JI-1)=T		0
	T=A(1J)		1
	A(IJ)=A(JI)	FT 9	12
	A(J1)=T	FT 9	3
11	IJ=IJ+2	FT 9	4
	IF (IFS) 12,2,14	FT 9	5
C	DDING FOURIER ANALYSIS, SO DIV. BY N AND CONJUGATE.		15
12	FN=N		7
1.	00 1-3 I=1.N		8
	A(2+I-1)=2(2+I-1)/FN		9
13	A(2+1)==A(2+1)/FH	FT 10	
C	SPECIAL CASE- L=1	FT 10	1
14	00 15 I=1,N,2	FT 10	. 20
	T=A(2*I-1)	FT 10	3
	A(2*I-1)=T+A(2*I+1)	FT 10	4
	A(2+I+1)=!-A(2+I+1)	FT 10	5
	T=4(2*I)	FT 10	6
	4(2+1)=1+4(2+1+2)	FT 10	
15	4(2*1*3)4-7=(2*1*5)4	FT 10	
	1F (4-1) 2,3,16	FT 10	
C	SET FOR L=2	FT 11	
16	LExp1=5	FT 11	
C	LEXP1=2**(L-1)	FI 11	
	LEXP=8	FT 11	
C	LEXP=2**(L+1)	FT 11	
	NPL=2**MT	FT 11	
C	NPL = NP+ 2++-L	FT 11	6

```
M'2=7 22 00
                                                                                 FT 117
      SPECIAL CASE- J=0
C
                                                                                 FT 118
       DO 17 I=2, N2, LEXP
                                                                                 FT 119
       II=I+LEXPI
                                                                                 FT 120
       12=11+LEXP1
                                                                                 FT 121
       13=12+LEXP1
                                                                                FT 122
       T=A(I-1)
                                                                                 FT 123
                                                                                FT 124
       A(1-1)=T+A(12-1)
       (1-SI)A-T=(12-1)A
                                                                                 FT 125
       (I)A=T
                                                                                FT 126
       (SI) 4+1=(I)A
                                                                                FT 127
       (S1) A-T=(S1) A
                                                                                 FT 128
       T==A(13)
                                                                                FT 129
       TI=4(13-1)
                                                                                 FT 130
                                                                                FT 131
       A(13-1)=A(11-1)-T
       A(13)=A(11)-TI
                                                                                FT 132
                                                                                FT 133
FT 134
       A(I1-1)=A(I1-1)+T
17
       A(11)=A(11)+TI
       IF (L-2) 21,21,18
                                                                                FT 135
18
       KLAST=N2-LEXP
                                                                                FT 135
       JJ=NPL
                                                                                FT 137
       DO 20 J=4, LEXP1, 2
                                                                                 FT 138
      KPJJ=NT-JJ
                                                                                FT 139
      UR=S(NPJJ)
                                                                                 FT 140
                                                                                 FT 141
      UI=S(JJ)
       ILAST=J+KLAST
                                                                                FT 142
                                                                                FT 143
FT 144
      DO 19 I= J. ILAST, LEXP
      11=1+LEXP1
      IZ=II+LEXP1
                                                                                 FT 145
      13=12+LEXP1
                                                                                FT 146
       IU*(21) 4-AU*(1-21) A=T
                                                                                FT 147
    * TI=A(12-1)*UI+A(12)*UR
                                                                                FT 148
      T-(1-1)A=(1-1)-T
                                                                                FT 149
                                                                                FT 150
FT 151
      17-(1)A=(51)A
      A(I-1)=A(I-1)+T
       IT+(I) 4=(I) 4
                                                                                FT 152
       T=-A(13-1) +U1-A(13) +UR
                                                                                FT 153
       TI=A(13-1)*UR-A(13)*UI
                                                                                FT 154
       A(13-1)=A(11-1)-T
                                                                                FT 155
      A(13)=A(11)-TI
                                                                                FT 156
                                                                                FT 157
FT 158
       A(I1-1)=A(I1-1)+T
19
      A(11) = A(11) + TI
      END UF I LOOP
                                                                                FT 159
20
      JJ=JJ+NPL
                                                                                FT 160
      END OF J LOOP
                                                                                FT 161
      LEXP1=2*LEXP1
                                                                                FT 162
21
      LEXP=2+LEXP
                                                                                FT 163
55
      NPL=NPL/2
                                                                                FT 164
                                                                                FT 165
      END OF L LOOP
C
      1F (1FS) 23,2,3
                                                                                FT 166
                                                                                FT 167
C
      DOING FOURIER ANALYSIS. REPLACE A BY CONJUGATE.
      N.1=1 45 00
23
                                                                                FT 168
      (1+5) +-=(1+5) A
                                                                                FT 169
24
                                                                                FT 170
      GO TO 3
      RETURN
                                                                                FT 171
      MAKE TABLE OF S(J)=SIN(2+P1+J/NP),J=1,2,...NT=1,NT=NP/4
                                                                                FT 172
25
      NPEN
                                                                                FT 173
                                                                                FT 174
FT 175
      MPSM
      NTEN/4
      S-METM
                                                                                FT 176
```

	IF (MT) 31,31,26		FT 177
26	THETA= . 785398163		FT 178
C	THETA=F1/2+4(L+1) FOR L=1		FT 179
	JSTEP=NT		FT 180
C	JSTEP = 2 ** ( MT-L+1 ) FOR L=1		FT 181
	J01F=NT/2		FT 182
C	JOIF = 2**(MT+L) FOR LE1		FT 183
	S(JOIF)=SIN(THETA)		FT 184
	IF (MT-2) 31,27,27		FT 185
27	DO 30 L=2,MT		FT 186
1000	THETA=THETA/2.		FT 187
	JSTEP2=JSTEP		FT 188
	JSTEP=JDIF		FT 189
	JDIF=JDIF/2		FT 190
	S(JDIF)=SIN(THETA)	<i>\</i>	FT 191
	JC1=NT-JD1F		FT 192
	S(JC1)=COS(THETA)		FT 193
	JLAST=NT-JSTEP2		FT 194
	IF (JLAST-JSTEP) 30.28.28		FT 195
85	DO 29 J=JSTEP, JLAST, JSTEP		FT 196
20	JC=NT-J		FT 197
	JD=J+JDIF		FT 198
20	S(J0)=S(J)+S(JC1)+S(J01F)+S(JC)		FT 199
29	CONTINUE		FT 200
30			FT 201
31	IF (IFS) 7,3,7 END		FT 202-

	SUBROUTINE IFEH (I)	IF	1
		IF	5
	IFEH CONVERTS I FROM E, H, OR BLANK TO 1, -1, OR O.	IF	3
		1F	4
	DATA IE, IH/1HE, 1HH/	15	5
	IF (1.E9.1E) GU TO 1	IF	6
	IF (1,EQ,IH) GO TO 2	IF	7
	1=0	15	8
	RETURN	1F	9
1	1=1	IF	10
	RETURN	IF	11
2	I=-1	IF	12
	RETURN	IF	13
	END	1F	14-

```
SUBROUTINE INTEG (EL, B, C)
                                                                                IN
C
                                                                                IN
      INTEG COMPUTES 12 INTEGRALS NEEDED TO SET UP THE FIELD
                                                                                IN
                                                                                IN
                                                                                IN
      COMMON /INTG/ X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12
                                                                                IN
      DOUBLE PRECISION 52,51,P15,R25,R1,R2,B2,HB, DE1, DE2,DIS, ALR,DIH,
                                                                                IN
     1 0519,0629,71,72,02,03,04,08
                                                                                IN
      $2=EL+.5
                                                                                IN
      $1=-52
                                                                                IN
                                                                                     10
      R15=(51+H)+S1+C
                                                                                IN
                                                                                     11
      H2S=(S2+8)+S2+C
                                                                                IN
                                                                                     12
      RI=OSORT(RIS)
                                                                                IN
                                                                                     13
      R2=DSORT (R2S)
                                                                                IN
                                                                                     14
      82=B+B
                                                                                IN
                                                                                     15
      H8= .5+8
                                                                                IN
                                                                                     16
      DE1=51+HB
                                                                                IN
                                                                                    17
      DE2=52+HB
                                                                                IN
                                                                                     18
      D15=4. +C-82
                                                                                IN
                                                                                     19
                                                                                IN
      ALR=DLOG(R2/R1)
                                                                                     20
      LIM=0
                                                                                IN
      IF (ABS(B).LT.1.E-27) GO TO 2
                                                                                IN
                                                                                    22
      XLIM=DIS/AHS(B)
                                                                                IN
                                                                                     23
      1F (*L14.GT.1.E-5) GO TO 2
                                                                                IN
                                                                                     24
                                                                                IN
                                                                                     25
      LIMEI
      DIH=0.0+0
                                                                                IN
                                                                                     26
      IF (DE1+DE2.G1.0.) GO TO 1
                                                                                IN
                                                                                     21
      PRINT 10, B,C
                                                                                IN
                                                                                     28
                                                                                     29
      STOP
                                                                                IN
      DE1S=DE1+DE1
                                                                                IN
                                                                                     30
      DESS=DE2+DE2
                                                                                IN
                                                                                    31
                                                                                IN
      GO TO 3
                                                                                    35
      DIH=DSGRT(DIS)
                                                                                IN
                                                                                    33
      X1=EL
                                                                                IN
                                                                                    34
      IF (DE1.LT.O.) GO TO 4
                                                                                IN
                                                                                    35
      D2=DLOG((R2+DE2)/(R1+DE1))
                                                                                IN
                                                                                    36
      GO TO 5
                                                                                IN
                                                                                    37
      D2=DEUG((R1-DE1)/(R2-DE2))
                                                                                IN
                                                                                    38
                                                                                    39
      $0=5X
                                                                                IN
      IF (LIM.EQ.1) GO TO 6
                                                                                IN
                                                                                    40
      (HIO/SEO*, S) NATAGEST
                                                                                IN
                                                                                    41
      TI=DATAN(2. *DE1/DIH)
                                                                                IN
                                                                                    42
      D3=2.*(12-11)/DIK
                                                                                IN
                                                                                    43
      D4=4. + (DF2/R2-DE1/R1)/DIS
                                                                                IN
                                                                                    44
      GO TO 7
                                                                                    45
      D3=(DIS/(12.*DE2*DE2)-1.)/DE2-(DIS/(12.*DE1*DE1)-1.)/DE1
                                                                                IN
                                                                                    46
      04=.5.0A85((DE2/DE1-DE1/DE2)/(R1.P2))
                                                                                    47
                                                                                IN
      x3=05
                                                                                IN
                                                                                    48
                                                                                    49
      X4=04
                                                                                IN
      X5=0.
X6=R2-R1-H8+02
                                                                                IN
                                                                                    50
                                                                                    51
                                                                                IN
      X7=AL4-H9+03
                                                                                IN
                                                                                    52
      IF (LIM.FO.1) GO TO 8
                                                                                IN
                                                                                    53
                                                                                    54
      D6=-2.*((H*S2+2,*C)/R2-(B*S1+2,*C)/R1)/D18
                                                                                IN
      60 TU 4
                                                                                IN
                                                                                    55
      D8=,25+(B/DE2S-B/DE1S)+1,/DE1-1./DE2
                                                                                    56
```

	IF (DE1.LT.O.) D8==D8	IN	57
9	x6=D8	IN	58
	x9=EL*EL/12.	IN	59
	x10=,5*((\$2=1,5*8)*R2-(\$1=1,5*8)*R1)+,125*(3,*82-4,*C)*D2	IN	60
	X11=S2-S1-B*ALK+,5+(B2-2,*C)*D3	IN	61
	x12=02-d*08-C*04	IN	62
	RETURN	IN	63
C		IN	64
C		IN	65
10	FORMAT (1x,45HINTEGRATION ATTEMPTED OVER SINGULARITY, B,C=,2E15.6	IN	66
	1)	IN	67
	END	IN	68-

	FUNCTION ISEGNO (ITAGI, M)	18	1
C	ISEGNO RETURNS THE SEGMENT NUMBER OF THE MIN SEGMENT HAVING THE	15	3
C	TAG NUMBER ITAGI. IF ITAGI=3 SEGMENT NUMBER M IS RETURNED.	13	4
C	CONTROL (0.14 ( 0.10 V(200) V(200) 7/200) CT/200) HT/2001 HT/2001	13	,
	COMMON /DATA/ N,NP,X(200),Y(200),Z(200),SI(200),BI(200),ALP(200), 1 BET(200),ICUN1(200),ICUN2(200),ITAG(200),IPX,IPY,IPZ	13	7
	1F (M,GT,0) GO TO 1	13	
	PRINT 5	15	0
	STUP	13	10
	1CNT=0	13	11
	IF (ITAGI, NE, 0) GO TO 2	IS	15
	ISEGNO=M	15	13
	RETURN	IS	14
2	DO 3 I=1,N	13	15
	IF (ITAG(I), NE.ITAGI) GO TO 3	15	16
	ICNT=ICNT+1	18	17
	IF (ICNT.EG.M) GU TO 4	15	18
3	CONTINUE	15	19
	PRINT 6, ITAGI	13	20
	STOP	13	21
4	ISEGNO=1	IS	22
	RETURN	13	23
C		13	24
5	FORMAT (4x, 91HCHECK DATA, PARAMETER SPECIFYING SEGMENT POSITION IN	19	25
	1 A GROUP OF EQUAL TAGS MUST NOT BE ZERU)	15	26
6	FURMAT (///, 10x, 26HNU SEGMENT HAS AN ITAG OF , 15)	13	27
	END .	18	28-

```
SUBROUTINE ITOF (TRAN, NT, M, NOE, NOC, NTNX, NTNR)
                                                                               11
                                                                               IT
CC
      ITOF PROCESSES DATA IN ARRAY TRAN FOR FOURIER TRANSFORMING AND
                                                                               11
      CALLS SUBROUTINE FORT TO DO THE TRANSFURMING
                                                                               IT
C
                                                                               IT
      COMMON /ARRAX/ GI1,GI2,GI3,ET(200,5,8),EP(200,5,8),IHET(200,8)
      DIMENSION TRAN(1024), A(4090), S(511)
                                                                               IT
      DIMENSION TZERU(100), AMAX(100), TEXT(100)
      EQUIVALENCE (A.GII), (TZERO, EP(1,1,2)), (AMAX, EP(1,1,3)), (TEXT, EP IT
     1(1,1,4))
                                                                               IT
                                                                                   10
             MMAX, ITZX/0,100/
      DATA
                                                                               IT
                                                                                   11
      PI=3,1415925
                                                                                   12
                                                                               IT
      TP=2.*PI
                                                                               IT
                                                                                   13
      IFERR=0
                                                                                   14
                                                                               IT
                                                                                   15
      M=5++W
                                                                               IT
      PRINT 24, NY, N
                                                                               IT
                                                                                   16
      N2=N+2
                                                                               IT
                                                                                   17
      NTP=NT+1
                                                                               IT
                                                                                   18
      DO 1 1=1.NT
                                                                               11
                                                                                   19
      A(I)=TRAN(I)
                                                                               IT
                                                                                   20
      IF (NI,LT.N) GO TO 2
                                                                               IT
                                                                                   21
      NTEN
                                                                               IT
                                                                                   22
      GO TO 12
                                                                                   23
      IF (NOE.NE.O) GO TO 12
                                                                               IT
                                                                                   24
                                                                                   25
      EXAMINE DATA FOR POSSIBLE EXTRAPOLATION
C
                                                                               IT
                                                                                   25
                                                                                   27
      NTH=NT-1
                                                                                   28
                                                                               IT
      ITZ=0
                                                                               IT
                                                                                   29
                                                                                   30
      ITH=0
      DO 4 1=3, NTM
                                                                               IT
                                                                                   31
       THA=A(I-1)
                                                                               IT
                                                                                   32
       THB=A(I)
                                                                                   33
                                                                               IT
      TRC=A(I+1)
                                                                               IT
                                                                                   34
                                                                                   35
      ATRA=ADS(TRA)
                                                                               IT
      IF (ATRA, LT. 1. E-35) GO TO 3
                                                                               IT
                                                                                   36
       IF (1.E+10+TRA+THB.GT.O.) GO TO 3
                                                                               IT
                                                                                   37
      ITZ=ITZ+1
                                                                               IT
                                                                                   38
       IF (117.GT.172x) GO TO 11
                                                                                   39
       TZERO(ITZ)=FLOAT(I-2)+ABS(TRA/(TRA-TRB))
                                                                                   40
      ATRA=ABS(TRA)
                                                                                   41
3
                                                                               IT
      ATRBESAS(THB)
                                                                                   42
      ATRC=ABS(TRC)
                                                                                   43
                                                                               IT
       IF ((ATRB.LE.ATRA).DR.(ATRB.LT.ATRC)) GO TO 4
                                                                                   44
       TMAXI=TRA-2. +TRB+TRC
                                                                                   45
                                                                               IT
       IF (ABS(TMAXI).LT.1.E-35) GO TO 4
                                                                               IT
                                                                                   46
      1TH=ITH+1
                                                                               IT
                                                                                   47
      IF (ITM.GT.ITZX) GU TO 11
                                                                                   48
                                                                               IT
       TMAXIS-.5+(TRC-THA)/TMAXI
                                                                                   49
      TEXT(ITM)=TMAXI+FLGAT(I-1)
                                                                                   50
       AMAX(ITM)=(.5*TPA-TRB+.5*TRC)*TMAXI*TMAXI+(TRC-TRA)*.5*TMAXI+TRB
                                                                                   51
      CONTINUE
                                                                               IT
                                                                                   52
                                                                                   53
       IF (ITM.LT.3) GO TO 11
      ALFA=0.
                                                                               11
                                                                                   54
      ICOUNT = 0
                                                                               IT
                                                                                   55
      1595=2
```

```
AMAXL=AMAX(2)
                                                                                 IT
      DO 7 1=5,1TM
                                                                                 IT
                                                                                     58
      (I) XAMAEIXAMA
                                                                                 IT
                                                                                     59
      IF (AMAXI + AMAXL.GE.O.) GO TO 5
                                                                                     60
      ICOUNT=ICOUNT+1
                                                                                 IT
                                                                                     61
      AMAXR = - AMAXI / AMAXL
                                                                                 IT
                                                                                     62
      IF (AMAXR. GT. 1.) GO TO 5
                                                                                 IT
                                                                                     63
      ALFA=ALFA+ALOG(AMAXR)/(TEXT(1-1)-TEXT(1))
                                                                                 IT
                                                                                     64
      GO TO 6
                                                                                 IT
                                                                                     65
      ICOUNT=0
5
                                                                                 IT
                                                                                     66
      1559=1
                                                                                 IT
                                                                                     67
      ALFA=0.
                                                                                 IT
                                                                                     66
      IXAMAELXAMAXI
                                                                                 IT
                                                                                     69
      CONTINUE
                                                                                 IT
                                                                                     70
      IF (ICOUNT.LT.3) GO TO 11
                                                                                 IT
                                                                                     71
      ALFA=ALFA/FLOAT(ICOUNT)
                                                                                 11
      TMAXI=TEXT(ISSS)
                                                                                     73
                                                                                 IT
      00 8 1=1,172
                                                                                 IT
                                                                                     74
      ICOUNT=I
                                                                                 IT
                                                                                     75
      IF (TZERO(I),GT,TMAXI) GO TO 9
                                                                                 IT
                                                                                     76
      CONTINUE
                                                                                     77
                                                                                 IT
      GO TO 11
                                                                                     78
                                                                                 IT
      PERI=2. * (TZERO(ITZ) - TZERO(ICOUNT)) /FLOAT(ITZ-ICOUNT)
                                                                                 IT
                                                                                     79
      OMEGA=1P/PERI
                                                                                 IT
                                                                                     80
      TZERX=TZERO(ITZ)
                                                                                 IT
                                                                                     81
      TEND=FLOAT(NT-1)
                                                                                 IT
                                                                                     82
      AMX=A(NT)/SIN(OMEGA+(TEND-TZERX))
                                                                                     83
                                                                                 IT
      PRINT 21, ALFA, UMEGA
                                                                                 IT
                                                                                     84
                                                                                 IT
                                                                                     85
C
      EXTRAPOLATE WITH ATTENUATED SINE WAVE
                                                                                 IT
                                                                                     85
C
                                                                                 IT
                                                                                     87
      DO 10 I=NTP.N
                                                                                 IT
                                                                                     88
      TIM=FLUAT(I-1)
                                                                                     89
                                                                                 IT
      A(I)=AMX*EXP(-ALFA*(TIM-TEND))+SIN(OMEGA*(TIM-TZERX))
                                                                                     90
10
                                                                                 IT
      NTX=N
                                                                                 IT
                                                                                     91
      GO TO 14
PRINT 22
                                                                                     92
                                                                                 IT
                                                                                 IT
                                                                                     93
15
      NTX=NT
                                                                                 IT
                                                                                     95
C
                                                                                 IT
      NO EXTRAPOLATION
                                                                                 IT
                                                                                     96
Č
                                                                                     97
                                                                                 IT
                                                                                    98
      DO 13 I=NTP,N
                                                                                 IT
      A(I)=0.
13
                                                                                     99
                                                                                 IT
                                                                                 IT 100
      IF (NOC.NE.O) GO TO 16
14
                                                                                 17 101
      APPLY HALF COSINE BELL TAPER TO LAST 1/10 OF POINTS
                                                                                   102
                                                                                 IT
                                                                                 IT
                                                                                    103
      NTP=NTX/10
                                                                                 IT 104
      IF (NTP.LT.1) GO TO 15
                                                                                 IT 105
      NTHENTX-NTP+1
                                                                                 IT 105
      TRASPI/FLOAT (NTP+1)
                                                                                 IT 107
      TRB=0.
DO 15 I=NTM,NTX
                                                                                 IT 108
                                                                                   109
                                                                                 IT
      TRB=TRB+TQ4
                                                                                 IT 110
      A(I)=A(I)+(1.+COS(TRB))+.5
15
                                                                                 IT 111
      NTP=N+1
                                                                                 11 112
16
      DO 17 1=1.N
                                                                                 IT
                                                                                   113
      ITZ=NTP-I
                                                                                 IT 114
      ITM=2+ITZ
                                                                                 IT 115
                                                                                 IT 116
       A(114)=0.
```

```
A(ITM-1)=A(ITZ)
17
                                                                                                   IT 117
        IF (M.LE. MMAX) GO TO 18
                                                                                                   IT 118
        MEXAMM
                                                                                                   IT 119
        3(1)=0.
                                                                                                   IT 120
        IFS=-1
                                                                                                   11 121
                                                                                                   11 155
        60 TO 19
16
        1F5=-2
       CALL FORT (4, M, S, IFS, IFERR)

IF (IFERR, NE, 0) PHINT 23, IFERR

IF (IFERR, EQ. 1) STOP
                                                                                                   17 124
                                                                                                   11 125
                                                                                                   IT 126
        NTNREN
                                                                                                   11 127
        IF (N.GT.NTNX) NTNR=NTNX
                                                                                                   11 158
        DO 20 I=1, NTNR
                                                                                                   11 129
        TRAN(I)=A(I)
20
                                                                                                   IT 130
        RETURN
                                                                                                   IT 131
                                                                                                   11 135
                                                                                                   IT 133
        FORMAT ( 1x,84HINPUT DATA EXTRAPOLATED USING ATTENUATED SINE FUN IT 134
21
      1CTION EXP(-A+T)+SIN(W+T) WITH A+DT=,E12.5,10H AND W+UT=,E12.5) IT 135
FORMAT (1x,27HINPUT DATA NOT EXTRAPOLATED) IT 136
FORMAT (//,1x,46HERROR FLAG RETURNED BY SUBROUTINE FORT, IFERH=,I IT 137
55
23
      14,/)
                                                                                                   IT 138
                                                                                                   IT 139
IT 140
24
        FORMAT ( /,1x,21HFOURIER TRANSFORM - -,/.1x,23HNUMBER OF POINTS
       11NPUT=, 17, /, 1X, 29HNUMBER OF POINTS TRANSFORMED=, 17)
        END
                                                                                                   IT 141-
```

# BEST AVAILABLE COPY

	- 601 1		
	SUBROUTIN' LFACTR (A,N,IX1,IX2,P)	LF	1
c		LF	2
c	5/8 WHICH PERFORMS GAUSS-DOOLITTLE MANIPULATIONS ON THE TWO BLOCKS		3
00000	UNFACTORED OR PARTIALLY-FACTORED MATRIX WHICH IS IN THE CORE STORA		4
ċ		LF	5
-	THE MANIPULATIONS ARE BASED ON THE GAUSS-DOOLITTLE ALGORITHM PRESE	LF	6
-	PAGES 411-416 OF A. RALSTON A FIRST COURSE IN NUMEPICAL ANALYST		7
-		LF	7.
C	COMMENTS RELOW REFER TO COMMENTS IN RALSTONS TEXT.		8
	COMMON /MATPAR/ ABLOKS, NPBLK, NLAST, INT	LF	9
	COMMON /SCHATM/ D(200)		10
	DIMENSION A(N,N), P(N)		11
	INTEGER H.R1,R2,P,PJ,PR		15
			13
	IFLG=0	LF 1	14
C			15
C	INITIALIZE R1, H2, J1, J2	LF 1	16
000		LF 1	17
	L1=IX1.EG.1.AND.IX2.EQ.2	LF !	18
	L2=(1x2-1).E0.Ix1	LF !	19
	L3=IX2,ED,NBLOKS	LF 2	20
	IF (L1) GO TO 1		21
	\$ 07 09		25
1	R1=1	-	23
	R2=2*NPBLK		24
	J161		25
			26
	d J2:-1		27
	60 10 5		28
2	R1=NPBLK+1		
	RS=S+NP8LK		29
	J = ((x1-1)*NP8LK+1		-
	14 (15) 90 40 3		31
	60 TO 4		35
3	J2=J1+NPRLK-2		3 3
	GO TO 5		34
4	J2=J1+NP5LK-1		35
5	IF (L3) R2=NPBLK+NLAST		36
	J2P2S=J2*2	LF :	37
	00 16 RER1,R2	LF :	38
C	등이 많은 하지 않는 것은 이 보이 되는 것은 모든 모든 경험이 되었습니다. 그 이 없는 동안 되었습니다.	LF !	59
C	STEP 1	LF 6	40
C		LF	41
	00 6 K=J1,N	LF 6	42
	D(K)=A(K,R)	LF 6	43
	CONTINUE	LF 6	44
,			45
c	STEPS 2 AND 3		46
č	3.2.3 2 1.40 3		47
	1F (L1.0R.L2) J2=J2+1		e n
	th (11'01'15) 80 to a		9
			50
	1XJ=0		51
	00 A J#J1,J2		35
	IAJ=IXJ+1		
	PJ=P(J)		3
	A(J,R)=0(PJ)		-
	0(PJ)=D(J)		
	J <sup>2</sup> 1=J+1	LF	56

```
00 7 1=JP1,N
                                                                                    LF
                                                                                         51
      D(1)=D(1)-A(1,1XJ)+A(J,R)
                                                                                     LF
                                                                                         58
7
       CONTINUE
                                                                                     LF
                                                                                         59
       CONTINUE
                                                                                     LF
                                                                                         60
8
                                                                                     LF
       CONTINUE
                                                                                         61
                                                                                     LF
                                                                                         62
000
                                                                                     LF
       STEP 4
                                                                                         6.5
                                                                                     LF
                                                                                         64
                                                                                    LF
       J2F1=J2+1
                                                                                         65
      1F (L1.UR.L2) GO TO 11
1F (N.LT.J2P1) GO TO 16
                                                                                     LF
                                                                                         66
                                                                                     LF
                                                                                         67
       00 10 I=J2P1,N
                                                                                     LF
                                                                                         68
       A(1,R)=D(1)
                                                                                     LF
                                                                                         69
10
       CUNTINUE
                                                                                     LF
                                                                                         70
                                                                                    LF
       GU 10 16
                                                                                         71
       DMAX=AUS(D(J2P1))
                                                                                     LF
11
       P(J2P1)=J2P1
                                                                                     LF
                                                                                         73
                                                                                     LF
       J2P2=J2+2
                                                                                         74
       IF (J2P2.GT.N) GO TO 13
                                                                                         75
                                                                                     LF
       N,542F=1 21 00
                                                                                         76
       ELMAG=ABS(D(I))
                                                                                     LF
                                                                                         77
       IF (ELMAG, LT, DMAX) GO TO 12
                                                                                     LF
                                                                                         75
                                                                                     LF
                                                                                         79
       DMAX=FLMAG
       P(J2P1)=1
                                                                                         60
                                                                                     LF
       CONTINUE
                                                                                         81
12
13
       CONTINUE
                                                                                     LF
                                                                                         82
                                                                                     LF
                                                                                         83
       IF (DMAX.LT.1.E-10) IFLG=1
                                                                                     LF
                                                                                         84
       (1421) 4=84
       A(J2P1, 4)=D(PR)
                                                                                     LF
                                                                                         85
                                                                                     LF
                                                                                         86
       D(PR)=0(J2P1)
C
                                                                                     LF
                                                                                         37
                                                                                     LF
       STEP 5
                                                                                         88
                                                                                     LF
C
                                                                                         89
                                                                                     LF
       IF (J2P2.GT.N) GO TO 15
                                                                                         90
       00 14 1=J2P2,N
                                                                                     LF
                                                                                         91
       A(1,R)=D(1)/A(J2P1,R)
                                                                                     LF
                                                                                         92
                                                                                     LF
                                                                                         93
       CONTINUE
14
                                                                                         94
                                                                                     LF
15
       CONTINUE
       1F (1FLG.EQ.0) GO TO 16
PRINT 17, J2, DMAX
                                                                                     LF
                                                                                         95
                                                                                         96
                                                                                     LF
                                                                                         97
                                                                                     LF
       IFLG=0
       CONTINUE
                                                                                     LF
                                                                                         98
16
                                                                                         99
                                                                                     LF
       RETURN
                                                                                     LF 100
C
                                                                                     LF 101
       FORMAT (1H , 'PIVOT(',13,')=',E16.8)
17
       END
                                                                                       102-
```

```
SUBROUTINE LISOLY (A, AR, N, IX, B)
                                                                                LT
C
      S/R TO SOLVE THE MATRIX EQUATION Y(R)+LU(T)=B(R) WHERE (R) DENUTES LT
C
      ROW VECTOR AND LU(T) DENOTES THE LU DECOMPOSITION OF THE THANSPOSE LT
C
      OF THE ORIGINAL COEFFICIENT MATRIX. THE LU(T) DECOMPOSITION IS
                                                                                LT
      STORED ON FILE 13 IN BLOCKS IN ASCENDING ORDER AND ON FILE 14 IN
                                                                                LT
      BLOCKS OF DESCENDING DRDER.
C
                                                                                      7
                                                                                LT
C
                                                                                LT
                                                                                      8
C
                                                                                      9
      COMMON /HATPAR/ NBLOKS, NPBLK, NLAST, INT
                                                                                LT
                                                                                     10
      COMMON /SCRATM/ Y(200)
                                                                                LT
                                                                                     11
      DIMENSION A(N,N), B(N), IX(N), AR(1)
                                                                                LT
                                                                                     12
C
                                                                                LT
                                                                                     13
      FURNARD SUBSTITUTION
C
                                                                                LT
                                                                                     14
                                                                                LT
                                                                                     15
      11=1
                                                                                 LT
                                                                                     16
      IZ=NPBLK+N
                                                                                     17
      JEO
                                                                                LT
                                                                                     18
      DO 4 IXBLK1=1, NBLOKS
                                                                                 LT
                                                                                     19
      READ (13) (AR(1), 1=11,12)
                                                                                LT
                                                                                     20
      KZ=NPBLK
                                                                                LT
                                                                                     15
      IF (IXBLK1.EQ.NBLOKS) KZ=NLAST
      DO 3 K=1.K2
                                                                                LT
                                                                                     23
      JM1=J
                                                                                LT
                                                                                     24
      J=J+1
                                                                                LT
                                                                                     25
      SUM=0.
                                                                                LT
                                                                                     25
      IF (JM1.LT.1) GO TO 2
                                                                                LT
                                                                                     27
      DO 1 1=1, JM1
                                                                                LT
                                                                                     28
      SUM=SUM+A(I,K)+Y(I)
                                                                                LT
                                                                                     29
      CONTINUE
                                                                                LT
                                                                                     30
2
      CONTINUE
                                                                                LT
                                                                                     31
      Y(J)=(8(J)-SUM)/A(J,K)
                                                                                LT
                                                                                     32
3
      CONTINUE
                                                                                LT
                                                                                     33
      CONTINUE
                                                                                LT
                                                                                     34
                                                                                LT
                                                                                     35
CCC
      BACKWARD SUBSTITUTION
                                                                                LT
                                                                                LT
                                                                                     37
      J=N+1
                                                                                LT
                                                                                     38
      DO 8 IX9LK1=1,NBLOKS
READ (14) (AR(I),I=I1,I2)
                                                                                     39
                                                                                LT
                                                                                LT
                                                                                     40
      K2=NPBLK
                                                                                     41
                                                                                LT
                                                                                LT
      IF (IXBLK1.EQ.1) KZ=NLAST
                                                                                     42
      DO 7 K=1,K2
                                                                                     45
      KP=K2-K+1
                                                                                LT
                                                                                     44
      JP1=J
                                                                                LT
                                                                                     45
      J=J-1
                                                                                LT
                                                                                     46
      SUM=0.
                                                                                     47
                                                                                LT
      IF (N.LT.JP1) GO TO 6
                                                                                LT
                                                                                     48
      00 5 1=JP1,N
                                                                                LT
                                                                                     49
      SUM=SUM+A(I,KP)+B(I)
                                                                                     50
                                                                                LT
      CONTINUE
                                                                                LT
                                                                                     52
      CONTINUE
                                                                                LT
t
      B(J)=Y(J)-SUM
                                                                                     53
7
      CONTINUE
                                                                                LT
                                                                                     54
      CONTINUE
                                                                                LT
                                                                                     55
                                                                                LT
                                                                                     50
```

C	UNSCRAMBLE SOLUTION	LT	57
C		LT	58
	00 9 Isl.N	LT	59
	1x1=1x(1)	LT	60
	Y(IXI)=8(1)	LT	61
9	CONTINUE	LT	62
	DO 10 I=1,N	LT	63
10	B(I)=Y(I)	LT	64
40	REWIND 13	LT	65
	REHINO 14	LT	66
	RETURN	LT	67
	END	LT	68-

```
SUBROUTINE LUNSCR (A, AR, N, IX, IP)
                                                                                  LU
C
                                                                                  LU
CC
      3/R WHICH UNSCRAMBLES, SCRAMBLED FACTORED MATRIX
                                                                                   LU
                                                                                  LU
      COMMON /MATPAR/ NBLOKS, NPBLK, NLAST, INT
                                                                                   LU
                                                                                        5
      DIMENSION A(N,N), IP(N), IX(N), AR(1)
                                                                                        6
                                                                                  LU
                                                                                        7
      11=1
                                                                                  LU
      IZ=NPBLK*N
                                                                                  LU
                                                                                        8
      NM1=N-1
                                                                                  LU
      DO 4 IXBLK1=1, NBLOKS
                                                                                  LU
                                                                                       10
      READ (11) (AR(I), [=11,12)
                                                                                  LU
                                                                                       11
      K1=(IX8LK1-1)*NPBLK+2
                                                                                  LU
                                                                                       12
      IF (NM1.LT.K1) GO TO 3
                                                                                  LU
                                                                                       13
                                                                                  LU
       JS=0
                                                                                       14
      DO 2 K=K1, NM1
                                                                                  LU
                                                                                       15
      1F (J2, LT. NPBLK) J2=J2+1
                                                                                  LU
                                                                                       16
      IPK=IP(K)
                                                                                  LU
                                                                                       17
      00 1 J=1,J2
                                                                                  LU
                                                                                       18
       TEMP=A(K, J)
                                                                                  LU
                                                                                       19
      A(K,J)=A(IPK,J)
                                                                                  LU
                                                                                       20
      A (IPK. J) = TEMP
                                                                                  LU
                                                                                       51
      CONTINUE
                                                                                  LU
                                                                                       55
      CONTINUE
                                                                                  LU
                                                                                       23
3
      CONTINUE
                                                                                  LU
                                                                                       24
       WRITE (13) (AR(1), 1=11,12)
                                                                                  LU
                                                                                       25
      CONTINUE
                                                                                  LU
                                                                                       26
      DO 5 1XBLK1=1. NBLOKS
                                                                                  LU
                                                                                       27
      BACKSPACE 13
                                                                                  LU
                                                                                       28
      IF (IXBLK1.NE.1) BACKSPACE 13
READ (13) (AP(I), I=I1, I2)
                                                                                  LU
                                                                                       29
                                                                                  LU
                                                                                       30
       WRITE (14) (AR(I), I=11, 12)
                                                                                  LU
                                                                                       31
      CONTINUE
                                                                                  LU
                                                                                       32
5
                                                                                  LU
                                                                                       33
      DO 6 1=1,N
       Ix(1)=1
                                                                                  LU
                                                                                       35
                                                                                  LU
       CONTINUE
      00 7 I=1,N
                                                                                  LU
                                                                                       36
       171=1P(1)
                                                                                  LU
                                                                                       37
       IXT=IX(I)
                                                                                  LU
                                                                                       38
                                                                                       39
       1x(1)=1x(1P1)
                                                                                  LU
                                                                                  LU
                                                                                       40
       IX(IPI)=IXT
      CONTINUE
                                                                                  LU
                                                                                       41
7
                                                                                       42
       REMIND 11
                                                                                  LU
               13
       RENIND
                                                                                  LU
                                                                                       43
       REWIND
                                                                                  LU
                                                                                       44
               14
                                                                                       45
       RETURN
                                                                                  LU
                                                                                  LU
                                                                                       46 -
       END
```

```
SUBROUTINE MOVE (ROX, ROY, ROZ, XS, YS, ZS, ITS, NRPT, ITGI)
                                                                                MO
C
                                                                                     5
      SUBROUTINE MOVE MOVES THE STRUCTURE WITH RESPECT TO ITS
                                                                                MO
                                                                                     3
      COURDINATE SYSTEM OR REPRODUCES STRUCTURE IN NEW POSITIONS.
C
                                                                                MO
      STRUCTURE IS ROTATED ABOUT X,Y,Z AXES BY ROX, ROY, ROZ
C
                                                                                MO
                                                                                     5
                                                                                MO
C
      RESPECTIVELY, THEN SHIFTED BY XS, VS, ZS
                                                                                MO
      COMMON /DATA/ N,NP, X(200), Y(200), Z(200), SI(200), BI(200), ALP(200),
                                                                                MO
                                                                                     8
        BET(200), ICON1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ
                                                                                MO
                                                                                     9
      DIMENSION x2(1), Y2(1), Z2(1)
                                                                                MO
                                                                                    10
      EQUIVALENCE (X2(1), S1(1)), (Y2(1), ALP(1)), (Z2(1), BET(1))
                                                                                MO
                                                                                    11
      SPS=SIN(ROX)
                                                                                MO
                                                                                    12
      CPS=COS(ROX)
                                                                                MO
                                                                                    13
      STH=SIN(ROY)
                                                                                MO
                                                                                    14
      CTH=COS(ROY)
                                                                                MO
                                                                                    15
      SPH=SIN(ROZ)
                                                                                MO
                                                                                    16
      CPH=COS(ROZ)
                                                                                HO
                                                                                    17
      XX=CPH+CTH
                                                                                MO
                                                                                    18
      XY=CPH+STH+SPS-SPH+CPS
                                                                                MO
                                                                                    19
      XZ=CPH+STH+CPS+SPH+SPS
                                                                                MO
                                                                                    20
                                                                                MO
      YX=SPH*CTH
                                                                                    21
      YY=SPH+STH+SPS+CPH+CPS
                                                                                MO
                                                                                    25
      YZ=SPH+STH+CPS-CPH+SPS
                                                                                MO
                                                                                    23
      ZX=-STH
                                                                                MO
                                                                                    24
      ZY=CTH+SPS
                                                                                MO
                                                                                    25
                                                                                MO
      ZZ=CTH+CPS
                                                                                    26
      I1=ISEGNO(ITS,1)
                                                                                MO
                                                                                    27
      IX=I1
                                                                                MO
                                                                                    28
      NRPENRPT
                                                                                    29
      IF (NRPT.EQ.0) NRP=1
                                                                                MO
                                                                                    30
      KEN
                                                                                MO
                                                                                    31
      IF (NRPT.EG. 0) K=11-1
                                                                                MO
                                                                                    32
      DO 2 IR=1, NRP
                                                                                MO
                                                                                    33
                                                                                HO
      DO 1 I=11,N
                                                                                    34
      K=K+1
                                                                                MO
                                                                                    35
      XI=X(I)
                                                                                MO
                                                                                    36
                                                                                MO
                                                                                    37
      YI=Y(I)
      (I)Z=IZ
                                                                                MO
                                                                                    38
                                                                                    39
      X(K)=XI+YY+YI+XY+ZI+XZ+XS
                                                                                MO
      Y(K)=XI*YX+YI*YY+ZI*YZ+YS
                                                                                MO
                                                                                    40
      2(K)=XI+ZX+Y1+ZY+Z1+ZZ+ZS
                                                                                MO
                                                                                    41
      x1=x2(1)
                                                                                MO
                                                                                    42
      (1)SY=1Y
                                                                                MU
                                                                                    43
                                                                                MU
                                                                                    44
      (I) 52=IZ
      x2(K)=XI*XX+YI*XY+ZI*XZ+XS
                                                                                MO
                                                                                    45
      Y2(K)=XI+YX+YI+YY+ZI+YZ+YS
                                                                                MO
                                                                                    46
                                                                                MO
                                                                                    47
      Z2(K)=x1+ZX+Y1+ZY+Z1+ZZ+ZS
      BI(K)=91(1)
                                                                                MU
                                                                                    48
      ITAG(K)=ITAG(I)+ITGI
                                                                                HO
                                                                                    49
      CONTINUE
                                                                                MO
                                                                                    50
      11=N+1
                                                                                MO
                                                                                    51
      NEK
                                                                                MO
                                                                                    52
                                                                                HÜ
                                                                                    53
2
      CONTINUE
                                                                                MO
      RETURN
                                                                                    54
```

MO

55-

END

```
SUBROUTINE RFLD (THET, PHI, ETH, EPH, TSTRT, KLM)
                                                                               RF
                                                                               RF
      RFLD COMPUTES THE RADIATED FIELD IN THE DIRECTION THETA, PHI FOR
                                                                               RF
      ALL TIME STEPS PUSSIBLE WITH THE AVAILABLE CURRENTS
                                                                               RF
                                                                               RF
      COMMON /DATA/ N,NP,X(200),Y(200),Z(200),SI(200),BI(200),ALP(200),
                                                                               RE
        BET(200), ICUN1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ
                                                                               RF
      COMMON /SCOMP/ $x(200), $Y(200), $Z(200)
                                                                               RF
      COMMUN /INTERP/ AT(3,200),8T(3,200),CT(3,200),ES(3),FS(3),GS(3),
                                                                               RF
                                                                               RF
                                                                                   10
        E(3), H(3)
      COMMON /CONST/ COT, VEL, DT, NTSTEP
                                                                               RF
                                                                                    11
      COMMON /ARRAY/ G11,G12,G13,ET(200,5,8),EP(200,5,8),IHET(200,8)
                                                                               RF
      COMMUN /ARRAY/ CO(6400)
                                                                               RF
                                                                                   13
      COMMON /IOFLG/ NCFMX, NCOMY, IOC, IOCG, NTMAX, NBOUT, JP1, JP2
                                                                               RF
                                                                                    14
      DIMENSION A(3), B(3), C(3), P(3), ETH(1), EPH(1), ALFA(3,3)
                                                                               RF
                                                                                   15
                                                                               RF
      N2=N+2
                                                                                   16
      STH=SIN(THET)
                                                                               RF
                                                                                    17
      CTH=COS(THET)
                                                                                   18
      SP=SIN(PHI)
                                                                               RF
                                                                                   19
      CP=COS(PHI)
                                                                               RF
                                                                                   20
      ERX=STH+CP
                                                                               RF
                                                                                   21
                                                                               RF
      ERY=STH*SP
                                                                                   25
                                                                               RF
      ERZ=CTH
                                                                                   23
                                                                               RF
      THX=CTH+CP
                                                                                   24
      THY=CTH+SP
                                                                               RF
      THZ=-STH
                                                                               RF
                                                                                   26
      PHX=-SP
                                                                               RF
                                                                                   27
      PHY=CP
                                                                               RF
                                                                                   28
                                                                               RF
      KMN=9999
                                                                                    29
      IPLAN=0
                                                                               RF
                                                                                    30
      LPX=1
                                                                               RF
                                                                                   31
      LPY=1
                                                                               RF
      LPZ=1
                                                                               RF
                                                                                   33
      IF (IPX.NE.0) LPX=2
                                                                               RF
                                                                                   34
      IF (IPY.NE.O) LPY=2
                                                                                   35
      IF (IPZ.NE.0) LPZ=2
                                                                                   36
                                                                               RF
                                                                                    37
      BEGIN LOOP OVER SEGMENTS, INCLUDING IMAGES, TO COMPUTE
                                                                                   38
C
      COEFFICIENTS FOR RADIATED FIELD
                                                                               RF
                                                                                   39
                                                                               RF
                                                                                   40
                                                                               RF
      00 17 JX=1,LPX
                                                                                   41
      RFX=FLOAT(3-JX=2)
                                                                               RF
                                                                                   42
      SFX=HFX
                                                                               RF
                                                                                   43
      IF (IPx.LT.0) SFX=1.
                                                                               RF
                                                                                   44
      DO 17 JY=1, LPY
                                                                               RF
                                                                                   45
      RFY=FLOAT(3-JY+2)
                                                                               RF
                                                                                   46
      SFY=RFY
                                                                               RF
                                                                                   47
      IF (IPY.LT.0) SFY=1.
                                                                               RF
                                                                                   48
      DO 17 JZ=1,LPZ
                                                                               RF
                                                                               RF
      RFZ=FLOAT(3-JZ+2)
                                                                                   50
      SFZ=RFZ
                                                                               RF
      1F (1PZ.LT.0) SFZ=1.
                                                                               RF
                                                                                   52
      RFL=SFX*SFY*SFZ
                                                                               RF
                                                                                   53
      RFL=-1,E-7+RFL
                                                                               RF
                                                                                   54
                                                                               RF
                                                                                   55
      IPLANZIPLAN+1
      00 1 Ja1,N
                                                                               RF
```

```
AL=-(ERX+X(J)+RFX+ERY+Y(J)+RFY+ERZ+Z(J)+RFZ)
                                                                                  RF
                                                                                      57
                                                                                  RF
      TRET=AL/VEL
                                                                                      58
      K=TRET/DT+SIGN(,5,TRET)
                                                                                  RF
                                                                                      59
                                                                                  RF
      IRET(J, IPLAN) = K
                                                                                      60
      IF (K.LT.KHN) KMN=K
                                                                                  RF
                                                                                      61
      DO 1 M=1,5
                                                                                  RF
                                                                                      62
      ET(J,M, IPLAN)=0.
                                                                                  RF
                                                                                      63
      EP(J,M, IPLAN)=0.
                                                                                  RF
                                                                                      64
1
                                                                                  RF
      DO 16 J=1.N
                                                                                      65
      xJ=x(J)*RFX
                                                                                  RF
                                                                                      66
                                                                                  RF
      YJ=Y(J)*RFY
                                                                                      67
                                                                                  RF
      ZJ=2(J)*HFZ
                                                                                      68
      SXJ=SX(J)*RFX
                                                                                  RF
                                                                                      69
                                                                                  RF
      SYJ=SY(J) *HFY
                                                                                      70
      SZJ=SZ(J)*RFZ
                                                                                  KF
                                                                                      71
      AL = - (FRX + XJ+ERY+YJ+ERZ+ZJ)
                                                                                      72
      BA=-(ERX+SXJ+ERY+SYJ+ERZ+SZJ)
                                                                                  RF
                                                                                      73
      K= IRET (J, IPLAN)
                                                                                  RF
                                                                                      74
                                                                                  RF
      TAUSDI*FLOAT(K)
                                                                                      75
      00 2 L=1.3
                                                                                  RF
                                                                                      76
      A(L)=AT(L,J)
                                                                                  RF
                                                                                      77
                                                                                  RF
      B(L)=BT(L,J)
                                                                                      78
      C(L)=CT(L,J)
                                                                                  RF
                                                                                      79
      P(L)=2. *ES(L) *TAU+FS(L)
                                                                                  RF
2
                                                                                      80
      EL=SI(J)
                                                                                  RF
                                                                                      81
      ELC=EL*EL*EL/12.
                                                                                  RF
                                                                                      82
      SDUTT=SXJ*THX+SYJ*THY+SZJ*THZ
                                                                                  RF
                                                                                      83
      SDOTP=SXJ*PHX+SYJ*PHY
                                                                                  RF
                                                                                      84
                                                                                  RF
      DO 3 M=1,3
                                                                                      85
      T1=H(M) *AL+P(M)
                                                                                  RF
                                                                                      85
                                                                                  RF
      72=H(H)#8A
                                                                                      87
                                                                                  RF
      00 3 L=1,3
                                                                                      88
                                                                                  RF
                                                                                      89
      ALFA(L, M) = ((A(L) * T1 + B(L) * T2) * ELC+C(L) * T1 * EL) * RFL
3
      JC1=ICUN1(J)
                                                                                  RF
                                                                                      90
      IF (JC1.NE.0) GO TO 4
                                                                                  RF
                                                                                      91
      KKM=0
                                                                                  RF
                                                                                      92
                                                                                      93
      60 TO 8
                                                                                  RF
                                                                                  RF
      IF (JC1.LT.19000) GO TO 5
                                                                                      94
                                                                                  RF
                                                                                      95
      SIG1=FLUAT(JC1-20000)
                                                                                  RF
                                                                                      96
      JC1=J
                                                                                  RF
                                                                                      97
      GO 10 7
                                                                                  RF
      IF (ICON2(JC1).NE.J) GO TO 6
                                                                                      98
5
      SIG1=1.
                                                                                  RF
                                                                                      94
                                                                                  RF 100
      GO TO 7
                                                                                  RF 101
      IF (ICON1(JC1).NE.J) GO TO 23
      51G1=-1.
                                                                                  RF
                                                                                     102
                                                                                  RF 105
7
      KM=IRET(JC1, IPLAN)
                                                                                  RF 104
      KKM=KM-K
                                                                                  RF 105
      IF (1485(KKM).LE.1) GO TO 8
      PRINT 24, J.JCI.KKM
                                                                                  HF 106
                                                                                  RF 107
      STUP
      JC2=1C042(J)
                                                                                  RF 108
      IF (JC2.NE.0) GO TO 9
                                                                                  RF 109
      KKP=0
                                                                                  RF 110
                                                                                 RF 111
      GO TO 13
      IF (JC2.LT.19000) GD TO 10
                                                                                  RF 112
                                                                                 RF
       SIGE=FLOAT (JCZ-20000)
                                                                                    113
      JCS=7
                                                                                  RF 114
      60 TO 12
1F (ICON1(JC2),NE.J) GO TO 11
                                                                                  KF 115
                                                                                  HF
10
```

```
SIG2=1.
                                                                              RF 117
                                                                               RF 118
      GO TO 12
      IF (1CON2(JC2).NE.J) GO TO 23
                                                                              RF 119
11
      $162=-1.
                                                                              RF
                                                                                 150
      KP=INET(JCZ, IPLAN)
                                                                               RF 121
12
      KKP=KP-K
                                                                               RF 122
      IF (IABS(KKP).LE.1) GO TO 13
                                                                              RF 123
                                                                              RF 124
      PRINT 24, J.JCZ,KKP
      STOP
                                                                               RF 125
                                                                               HF
13
      00 15 Ma1,5
                                                                                 126
                                                                              RF 127
      KXX=M+1
                                                                               RF 128
      IF (JC1,EQ,0) GO TO 14
      KMX=KKM+KXX
                                                                              RF 129
                                                                              RF 130
      ET(JC1,KMx, IPLAN)=ET(JC1,KMX, IPLAN)+ALFA(1,M)+SDOTT+SJG1
                                                                              RF 131
      EP(JC1,KMX, IPLAN) = EP(JC1,KMX, IPLAN) + ALFA(1, H) + SDOTP + SIG1
      ET(J, KXX, IPLAN) = ET(J, KXX, IPLAN) + ALFA(2, M) + SOUTT
                                                                              RF 132
14
                                                                              RF 133
      EP(J, KXX, IPLAN) = EP(J, KXX, IPLAN) + ALFA(2, M) + SOOTP
                                                                              RF 134
      IF (JC2.EQ.0) GO TO 15
                                                                              RF 135
      ET(JC2,KPX,IPLAN)=ET(JC2,KPX,IPLAN)+ALFA(3,M)+SDOTT+SIG2
                                                                              RF 136
                                                                              RF 137
      EP(JC2, KPX, IPLAN) = EP(JC2, KPX, IPLAN) + ALFA(3, 4) + SOOTP + SIG2
                                                                               RF 139
      CONTINUE
15
                                                                              RF 139
16
      CONTINUE
                                                                              RF 140
      CONTINUE
                                                                              RF 141
                                                                              RF 142
      COMPUTE RADIATED FIELD AT ALL TIME STEPS POSSIBLE WITH SUMMATION
      PRUCEEDING IN URDER OF RETARDED TIMES
C
                                                                               RF
                                                                                 143
                                                                              RF 144
      KMN=KMN-1
                                                                              RF 145
                                                                              RF 146
      KKH=1
      KKP=NTSTEP
                                                                              RF
                                                                                 147
      KH=KKH+KHN
                                                                               RF 148
      KP=KKP+KHN
                                                                               RF 149
      KXX=KM-1
                                                                               RF 150
                                                                               RF 151
      KLM=KP-KXX
      TSTRT=DT*FLOAT(KXX)
                                                                               RF 152
                                                                               RF 153
      DO 18 K=1,KLM
      ETH(K)=0.
                                                                              RF
                                                                                 154
                                                                              RF 155
      EPH(K)=0.
18
                                                                              RF 156
      KTS=1
      NOC0=9999999
                                                                              RF
                                                                                 157
      IF (1000.EQ.0) GO TO 19
                                                                               RF 158
      REWIND 11
                                                                              RF 159
      READ (11) NOCO, (CO(J), J=1, NOCO)
                                                                              RF 160
                                                                              RF 161
      DO 25 KC=KKM,KKP
19
      KCB=(KC-1)+N2-KTS
                                                                              RF 162
                                                                              RF 163
      IF ((KCB+1).LT.NOCO) GO TO 21
      KTS=KTS+NOCQ
                                                                              RF 164
      READ (11) NOCQ. (CQ(J).J=1.NOCQ)
                                                                              RF 165
                                                                              RF 166
      GG TO 20
      KKH=KC-KXY+3
                                                                              RF 167
21
                                                                              RF 168
      DO 22 IPLNE=1, IPLAN
                                                                              RF 169
      N. 1=L SS CO
                                                                              RF 170
      KCC=KCB+2+J
      K=KK#+IRET(J, IPLNE)
                                                                              RF 171
      00 22 Ma1,5
                                                                              RF 172
                                                                              HF 173
      KPX=K-M
      IF (KPX.LT.1) GO TO 22
                                                                              RF 174
      IF (KPX.GT.KLM) GO TO 22
                                                                              RF 175
                                                                              RF 176
      ETH(KPX)=ETH(KPY)+ET(J,M,IPLNE)+CQ(KCC)
```

	EPH(KPX)=EPH(KPX)+EP(J,M,IPLNE)+CQ(KCC)	RF	177
22	CONTINUE	RF	178
	RETURN	RF	179
23	PRINT 25	RF	180
	STOP	RF	181
C		RF	182
24	FURMAT ( /.1x,26MRETARDED TIMES TO SEGMENTS,15,4H AND,15,	RF	183
	1 10H DIFFER BY, 15, 11H TIME STEPS)	HF	184
25	FORMAT (/,1x,62H***ERROR - ROUTINE RFLD INCUNSISTENT SEGMENT CON	RF	165
	INECTION DATA)	RF	186
	END	RF	187-

```
SUBROUTINE REPAT (ITRAN, IPCH, NTH, NPH, THET, PHI, OTH, OPH)
                                                                                       RP
       REPAT CALLS RELD TO COMPUTE THE RADIATED FIELD AT A SET OF ANGLES, RP
       THETA AND PHI. AND PRINTS THE RESULTS. THE COMPUTED FIELD CAN
                                                                                       RP
       ALSO BE FOURIER TRANSFORMED TO THE FREQUENCY DOMAIN
C
                                                                                       RP
                                                                                       RP
       COMMON /ESDRC/ ESDRC(1024), IFST, NTRAN, MTRAN, NTNX, DFRG, ENIN, ENRD, I RP
      IFEN
                                                                                       HP
      COMMON /CMAT/ CURF(1600), IP(200), IX(200)
COMMON /CONST/ CDT, VEL, DT, NTSTEP
COMMON /SCRATM/ PWR(512)
                                                                                       RP
                                                                                       RP
                                                                                            10
                                                                                       RP
       DIMENSION ETH(1024), EPH(1024), ETC(512), EPC(512), ESC(512), IPOL RP
      1(3)
                                                                                       RP
                                                                                            13
       COMPLEX
                  TPJ.CARG, FAZ, ETHC, EPHC, ETC, EPC, ESC
                                                                                       RP
                                                                                            14
       EQUIVALENCE (ETH, CURF), (ETC, CURF), (EPC, EPH), (ESC, ESORC)
DATA TA, TSMIN, TPJ/, 017453292, 5., (0., 6.2831853)/
                                                                                            15
                                                                                       RP
                                                                                            16
       DATA
               IPOL/6HLINEAR, SHRIGHT, 4HLEFT/, IBLK/1H /
                                                                                       RP
                                                                                            17
       TSTRT=0.
                                                                                            18
       NFLD=0
                                                                                       RP
                                                                                            19
                                                                                       RP
       TH=THET-DTH
                                                                                            20
       DO 15 IT=1, NTH
                                                                                       RP
                                                                                            15
       TH=TH+DTH
                                                                                       RP
                                                                                            55
       THA=TH+TA
                                                                                       RP
                                                                                            23
       PH=PHI-DPH
                                                                                       RP
                                                                                            24
       DO 15 IPH=1, NPH
                                                                                       RP
                                                                                            25
       PH=PH+DPH
                                                                                       RD
                                                                                            26
       PHA=PH+TA
                                                                                       RP
                                                                                            27
       PRINT 18,
                    TH, PH
                                                                                       RP
                                                                                            28
       CALL RFLO (THA, PHA, ETH, EPH, TSTRT, NFLO)
                                                                                       RP
                                                                                            29
       NPRT=NFLD/2
                                                                                       RP
                                                                                            30
       NADD=NPRT
                                                                                       RP
                                                                                            31
       IF (2+NPRT.NE.NFLD) NADD=NPRT+1
                                                                                            32
       TIMETSTRT-OT
                                                                                       RP
                                                                                            33
       TADD=DT+FLUAT(NADD)
                                                                                       RP
                                                                                            34
       DO 1 11=1, NPRT
                                                                                       RP
                                                                                            35
                                                                                       RP
       IZ=II+NADD
       TIMETIM+OT
                                                                                       RP
                                                                                            37
       DOAT+HIT=SMIT
                                                                                       RP
                                                                                            38
       POLI=ATGN2(EPH(I1),ETH(I1))/TA
                                                                                       RP
                                                                                            39
       POLZ=ATGN2(EPH(12),ETH(12))/TA
                                                                                       RP
                                                                                            40
       PRINT 19, 11, TIM, ETH(11), EPH(11), POL1, 12, TIM2, ETH(12), EPH(12), POL
                                                                                       RP
                                                                                            41
                                                                                            42
       IF (NADD. EQ. NPRT) GU TO 2
                                                                                       RP
                                                                                            43
       POL1=4TGN2(EPH(NADD),ETH(NADD))/TA
                                                                                       RP
                                                                                            44
       TIM=TSTRT+DT+FLOAT (NPRT)
                                                                                       RP
                                                                                            45
       PRINT 19, NADD, TIM, ETH (NADD), EPH (NADD), POL1
                                                                                       RP
                                                                                            40
                                                                                       KP
                                                                                            47
       COMPUTE RADIATED ENERGY
                                                                                       RP
                                                                                            48
                                                                                       RP
                                                                                            49
      F=0.
00 3 I=1, NFLD
                                                                                       RP
                                                                                            50
                                                                                       RP
                                                                                            51
       F=F+ETH(I) *ETH(I) +EPH(I) *EPH(I)
                                                                                       RP
                                                                                            52
                                                                                       MP
       F=F+DT/376.73
                                                                                            53
                   F, TH, PH
       PRINT 21, F,TH,PH
IF (IFEN.EQ.0) GO TO 4
                                                                                       RP
                                                                                            54
                                                                                       RP
                                                                                            55
       POLI=F/ENIN
                                                                                       RP
```

```
POL2 = F / ENRD
                                                                          RP
                                                                              57
IF (POL1.LT.1.E-20) GO TO 4
                                                                          RP
                                                                              58
POLI=10. *ALOGIO(POLI)
                                                                          RP
                                                                              59
POL2=10. *ALOG10(POL2)
                                                                          RP
                                                                              60
PRINT 20, PULI, POLZ
                                                                          RP
                                                                              61
IF (IPCH.EQ.O) GO TO 5
                                                                          RP
                                                                              62
                                                                          BP
                                                                              63
                                                                          RP
PUNCH FIELD VALUES
                                                                              64
                                                                          RP
                                                                              65
PUNCH 26, TSTRT, DT
                                                                          RP
                                                                              65
           NFLD, TH, PH
                                                                          RP
PUNCH 22,
                                                                              67
PUNCH 23,
            (ETH(1), I=1, NFLD)
                                                                          RP
                                                                              68
                                                                          RP
PUNCH 24,
            NFLD, TH, PH
                                                                              69
PUNCH 23,
            (EPH(I), I=1, NFLO)
                                                                          RP
                                                                              70
                                                                          RP
IF (ITHAN, EQ. 0) GO TO 15
                                                                          RP
                                                                              72
FOURIER TRANSFORM TO OBTAIN FREQUENCY RESPONSE
                                                                          RP
                                                                              73
                                                                          RP
                                                                              74
IF (IFST.EQ.1) GO TO 7
                                                                          RP
                                                                              75
MTRAN=ALOG(FLOAT(NTRAN))/.69314718+1.5
                                                                          RP
                                                                              76
CALL ITOF (ESORC, NTRAN, MTRAN, 1, 1, NTNX, NTNR)
                                                                          RP
                                                                              77
                                                                          RP
IFST=1
                                                                              78
                                                                          RP
DFRQ=1./(DT*FLOAT(2**MTRAN))
                                                                              79
NTNR=NTNR/2
                                                                          RP
                                                                              80
                                                                          RP
DO 6 I=1, NTNR
                                                                              81
                                                                          RP
PWR(1)=0.
                                                                              82
                                                                          RP
CALL ITOF (ETH, NTRAN, MTRAN, 0, 0, NTNX, NTNR)
                                                                              85
CALL ITOF (EPH, NTRAN, MTRAN, 0, 0, NTNX, NTNR)
                                                                          RP
                                                                              84
NTNR=NTNR/2
                                                                          RP
                                                                              85
                                                                          RP
FMAX=1./(TSMIN+DT)
                                                                              86
CARG=-TPJ+TSTRT
                                                                          RP
                                                                              87
PRINT 17
                                                                          RP
                                                                              88
                                                                          RP
IF (ITRAN.GT.1) PUNCH 25, TH,PH
                                                                              89
                                                                          RP
                                                                              90
F=-DFRQ
                                                                          HP
                                                                              91
DO 14 I=1, NTNR
                                                                          RP
F=F+DFRQ
                                                                              92
                                                                          RP
IF (F.GT.FMAX) GO TO 15
                                                                              93
                                                                          RP
                                                                              94
FQ=F+1.E-6
FAZ=CEXP(CARG*F)/ESC(I)
                                                                          RP
                                                                              95
                                                                          RP
ETHC=ETC(1)*FAZ
                                                                              96
                                                                          RP
                                                                              97
EPHC=EPC(1) +FAZ
ETHM2=REAL (ETHC +CONJG (ETHC))
                                                                          RP
                                                                              98
                                                                          RP
                                                                              99
EPHM2=HEAL (EPHC *CONJG (EPHC))
ETHM=SGHT(ETHM2)
                                                                          RP 100
                                                                          RP 101
EPHM=SURT (EPHM2)
ETHA=ATGN2(AIMAG(ETHC), REAL(ETHC))/TA
                                                                          RP 102
EPHA=ATGN2(AIMAG(EPHC), REAL(EPHC))/TA
                                                                          RP 103
IF (ETHM2.GT.1.E-20.OR.EPHM2.GT.1.E-20) GO TO 8
                                                                          RP 104
                                                                          AP 105
TILTA=0.
                                                                          RP 106
EMAJR2=0.
EMINH2=0.
                                                                          RP 107
                                                                          RP 108
AXRAT=0.
                                                                          RP 109
ISENS=IBLK
                                                                          RP 110
GO 10 13
                                                                          RP 111
DFAZ=EPHA-ETHA
                                                                          RP 112
IF (EPHA.LT.O.) GO TO 9
DFAZ2=DFAZ-350.
                                                                          HP 113
                                                                          RP 114
GO TO 10
DFAZZ=DFAZ+360.
                                                                          RP 115
IF (ABS(DFAZ), GT. ABS(DFAZ2)) DFAZ=DFAZ2
                                                                          RP 116
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```
RP 117
      COFAZ=COS(DFAZ*TA)
       TS1=ETHM2-EPHM2
                                                                                    RP
                                                                                        118
      TSZ=2. * EPHM * ETHM * COFAZ
                                                                                    RP
                                                                                       119
                                                                                    RP 120
      TILTA=,5*ATGN2(TS2,T91)
      STILTA=SIN(TILTA)
                                                                                    RP
                                                                                        121
       TS1=TS1 .STILTA .STILTA
                                                                                    RP
                                                                                        122
       TS2=TS2*STILTA*CUS(TILTA)
                                                                                    RP 123
      EMAJR2=-131+132+ETHM2
                                                                                     RP
                                                                                       124
      EMINR2=TS1-TS2+EPHM2
                                                                                    RP
                                                                                        125
       IF (EMINRZ.LT.O.) EMINRZEO.
                                                                                     RP
                                                                                       126
                                                                                    RP
       AXRAT=SORT (EMINR2/EMAJR2)
                                                                                       127
                                                                                     RP
       TILTA=TILTA/TA
                                                                                        128
                                                                                     RP
       IF (AXRAT.GT.1.E-5) GO TO 11
                                                                                        129
       ISENS=IPOL(1)
                                                                                    RP 130
      GO TO 13
IF (DFAZ,GT.O.) GO TO 12
                                                                                     RP
                                                                                        131
                                                                                     RP
11
                                                                                        132
       ISENS=IPOL(2)
                                                                                     RP
                                                                                        133
      GO TO 13
                                                                                    RP
                                                                                        134
                                                                                    RP
12
       ISENS=IPOL(3)
                                                                                        135
       WLAMEF
                                                                                        136
                                                                                    RP
       IF (WLAM.LT.1.6-25) WLAM=1.6-25
                                                                                       137
       WLAM=2.998E+8/WLAH
                                                                                    RP
                                                                                        138
      PUR=PWR(I)
                                                                                     RP
                                                                                        139
                                                                                    RP
       IF (POR.LT.1.E-25) POR=.0013273**LAM**LAM
                                                                                       140
      GTOT=.01668+(ETHM2+EPHM2)/POR
                                                                                    RP
                                                                                        141
                                                                                    RP
       IF (GTOT.LT.1.E-20) GTOT=1.E-20
                                                                                        142
                                                                                    RP 143
       GTOT=10. *ALUG10(GTOT)
      ETHM=ETHM/ALAM
                                                                                    RP
                                                                                       144
                                                                                    RP
      EPHM=EPHM/WLAM
                                                                                        145
      PRINT 16, I.FQ, ETHM, ETHA, EPHM, EPHA, AXRAT, TILTA, ISENS, GTOT
                                                                                    RP 146
                                                                                    RP
       IF (ITRAN.GT.1) PUNCH 16, I.FG, ETHM, ETHA, EPHM, EPHA
                                                                                        147
14
      CONTINUE
                                                                                    RP
                                                                                        148
                                                                                     RP
                                                                                        149
15
      CONTINUE
                                                                                    RP
       RETURN
                                                                                       150
C
                                                                                     RP
                                                                                        151
C
                                                                                     RP
                                                                                        152
16
       FORMAT (1x,15,E12.4,E13.4,F9.3,E15.4,F9.3,F11.5,F9.2,2x,A6.F14.3) RP
       FORMAT ( ///, 33x, 43H- - - FREQUENCY DOMAIN RADIATED FIELD - - -, RP
                                                                                        154
          //,2x,4HSTEP,2x,9HFREQUENCY,3x,20H- - - E(THETA) - - -,4x,
                                                                                    RP
                                                                                        155
          18H- - - E(PHI) - - -,6x,24H- - - PULARIZATION - - -,5x,
                                                                                     RP
                                                                                       156
                                                                                    RP 157
                 10HPOHER GAIN, /, 3x, 3HNO., 4x, 5H(HHZ), 6x, 9HMAGNITUDE, 4X,
          SHPHASE, 6x, 9HMAGNITUDE, 4x, 5HPHASE, 7x, 5HAXIAL, 5x, 4HTILT, 3X,
                                                                                     RP
                                                                                        158
                                                                                    RP
          SHSFNSE, 9x, 4H(DB), /, 22x, 7HVOLTS/M, 4x, 7HDEGREES, 6x, 7HVOLTS/M,
                                                                                        159
     6 4x,7HDEGREES,6x,5HRATIO,5x,4HDEG.)

FORMAT ( //,42x,30H= = = RADIATED FIELD = = = -.//,47x,6HTHETA RP

1=, F8.3./,47x,6HPHI =,F6.3.//,2(2x,4HSTEP,6x,4HTIME,8x,20HELECTRI RP
                                                                                    RP 160
18
                                                                                        161
                                                                                        162
     2C FIELD (V/M),4x,4HPOL,,8x),/,2(3x,3HNU,,5x,6H(SEC,),8x,5HTHETA,9x RP 163
                                                                                    RP 164
          3HPH1,5x,6H(DEG.),7x))
      FORMAT (2(1x,15,613.5,613.4,612.4,69.3,7x))
FORMAT ( 1x,244TIME DOMAIN POWER GAIN =,F7,
                                                                                    RP
                                                                                        165
                ( 1x, 24HTIME DOMAIN POWER GAIN =, F7, 2, 3H DB. /, 1x, 28HTIME
                                                                                    RP
20
                                                                                        166
     100MAIN DIRECTIVE GAIN =, F7, 2, 3H DR.//)
                                                                                    RP 167
     FORMAT ( //,1x,23HTOTAL ENERGY RADIATED =,E11.4,17H JOULES/STERA RP 1DIAN,3x,7H(THETA=,F8,3,12H DEG., PHI=,F8.3,6H DEG.)) RP
                                                                                        168
21
                                                                                        169
      FORMAT (15,2x,26HRADIATED FIELDS FUR THETA=,F8.3,11H DEG., PHI=,F RP 170
22
      18.3.18H DEG.,
                       THETA POL.)
                                                                                    RP 171
                                                                                    HP 172
23
       FORMAT (6612,5)
       FORMAT
                (15,2x,20HHADIATED FIELDS FOR THETA=,F8.3,11H DEG., PHI=,F
                                                                                    RP 173
24
                                                                                    RP 174
     18.3,16H DEG., PHI POL.)
      FORMAT (23HRADIATED FIELD. THETA=, $10.5,6H PHI=, $10.5)
                                                                                    RP 175
25
                                                                                    RP 176
       FORMAT (14HSTARTING TIME=, E12.5, 3x, 15HTIME INCREMENT=, E12.5)
26
      END
```

C	SUBROUTINE SECON	D (T)			
CCC	RETURNS CUMRENT	RUNNING	TIME	IN	SECONDS
	CALL TUSEOM (1) T=1/1000. RETURN				
	END				

\$E \$E \$E \$E \$E \$E \$E \$E

```
SUBROUTINE SOLVE (N.A.P.B.NDIM)
                                                                                               30
       SUBROUTINE TO SOLVE THE MATRIX EQUATION LU+X=B WHERE L IS A UNIT
                                                                                               SO
00000
       LOWER TRIANGULAR MATRIX AND U IS AN UPPER TRIANGULAR MATRIX BOTH OF WHICH ARE STORED IN A. THE RHS VECTOR B IS INPUT AND THE SOLUTION IS RETURNED THROUGH VECTOR B. (MATRIX TRANSPOSED)
                                                                                               50
                                                                                                      5
                                                                                               50
                                                                                               SO
                                                                                               90
       DIMENSION A(NDIM, NDIM), P(NDIM), B(NDIM)
                                                                                               SU
       COMMON /SCRATM/ Y(200)
INTEGER P,PI
                                                                                               30
                                                                                               SO
                                                                                                     10
                                                                                               SU
                                                                                                     11
       FORWARD SUBSTITUTION
                                                                                               30
                                                                                               50
                                                                                                     13
       00 3 I=1.N
                                                                                               SU
                                                                                                    14
       P1=P(1)
                                                                                               SU
                                                                                                     15
        Y(1)=8(P1)
                                                                                               50
                                                                                                    16
       B(PI)=B(1)
                                                                                               50
                                                                                                    17
        IP1=I+1
                                                                                               30
                                                                                                     18
        IF (IP1.GT.N) GO TO 2
                                                                                               SU
                                                                                                    19
       DO 1 J=IP1,N
                                                                                               50
                                                                                                    20
       B(J)=B(J)-A(I,J)+Y(I)
                                                                                               50
                                                                                                    21
       CONTINUE
                                                                                               30
                                                                                                    55
       CONTINUE
2 3 6
                                                                                               50
                                                                                                    23
       CONTINUE
                                                                                               30
                                                                                                    24
                                                                                               30
                                                                                                    25
ccc
        BACKWARD SUBSTITUTION
                                                                                               SU
                                                                                                    26
                                                                                               50
                                                                                                    27
       DU 6 K=1,N
I=N-K+1
                                                                                               SO
                                                                                                    28
                                                                                               $0
                                                                                                    29
        SUM=0.
                                                                                               50
                                                                                                    30
        IP1=I+1
                                                                                               50
                                                                                                    31
        IF (IPI,GT,N) GO TO 5
                                                                                               SO
                                                                                                     35
       00 4 J=IP1,N
                                                                                               30
                                                                                                    33
        SUM=SUM+A(J,1)+B(J)
                                                                                               50
                                                                                                    34
       CONTINUE
                                                                                               30
                                                                                                    35
       CONTINUE
5
                                                                                               SO
                                                                                                    36
        B(1)=(Y(1)-SUM)/A(1,1)
                                                                                               50
                                                                                                    37
       CONTINUE
                                                                                               30
                                                                                                    38
       RETURN
                                                                                               SO
                                                                                                    39
       END
                                                                                               50
                                                                                                    40-
```

```
SUBROUTINE TSOL (CURF, IX, IP, N)
                                                                                           13
C
                                                                                           TS
       TSOL COMPUTES STRUCTURE CURRENTS
                                                                                           TS
                                                                                           TS
       COMMON /CONST/ CDT, VEL, DT, NTSTEP
COMMON /EINC/ EINC(200), ESRC
COMMON /ARRAY/ CO(6400)
                                                                                           13
                                                                                           TS
                                                                                           TS
                           Q11,Q12,Q13,EC(200,5),EQ(200,5),IRET(200),BFR(1540 TS
       COMMON /ARHAY/
      10)
       COMMON /IOFLG/ NCFMX, NCOMX, IOC, IOCU, NTMAX, NBOUT, JP1, JP2
COMMON /MATPAR/ NBLOKS, NPBLK, NLAST, INT
                                                                                           TS
                                                                                                10
                                                                                           TS
       COMMON /ESORC/ ESORC(1024), IFST, NTRAN, MTRAN, NTNX, DFRG, ENIN, ENRD, I TS
      1FEN
                                                                                           TS
                                                                                                13
       DIMENSION ICOF(17600), COF(17600)
EQUIVALENCE (COF,EC), (ICOF,EC)
                                                                                           TS
                                                                                           15
                                                                                                15
       N2=N*2
                                                                                           TS
                                                                                                16
       N4P=2+N2+1
                                                                                           TS
                                                                                                17
       IC1=N2
                                                                                           TS
                                                                                                18
       ICS=NAB
                                                                                           TS
                                                                                                19
       ICL=9999999
                                                                                           TS
                                                                                                20
       IUL 1 M= 9999999
                                                                                           TS
                                                                                                21
       LCG=NCGMX/N2
                                                                                           TS
                                                                                                22
       NOCQ=LCQ-NTMAX+1
                                                                                           TS
                                                                                                23
       IF (NUCO.LT.1) GO TO 1
                                                                                           TS
                                                                                                24
       LCG=LCG*NS
                                                                                           TS
                                                                                                25
       NOCO=NOCO+NZ
                                                                                           13
                                                                                                26
                                                                                           TS
                                                                                                27
       L1=1
       L2=NOCQ
                                                                                           TS
                                                                                                28
       NSFT=LCG-NUCG
                                                                                           TS
                                                                                                29
       PRINT 36
                                                                                           TS
                                                                                                30
       S 01 09
                                                                                           TS
                                                                                                31
       NOCO=(LCQ/2)+N2
                                                                                           15
1
       IF (NOCQ.LT.N2) GO TO 35
                                                                                           TS
                                                                                                33
       FC0=5+NOCO
                                                                                           TS
                                                                                                34
       LI=NOCQ+1
                                                                                           TS
                                                                                                35
       FS=FC0
                                                                                           TS
                                                                                                36
       PRINT 37
                                                                                           TS
                                                                                                37
                                                                                           TS
       1000=0
                                                                                                38
2
       NBAS=0
                                                                                           TS
                                                                                                39
       ICFLG=0
                                                                                           TS
                                                                                                40
                                                                                           TS
                                                                                                41
       NELD=0
                                                                                           TS
                                                                                                42
       NECUTEO
       PRINT 38,
                     NOCG, NTMAX
                                                                                           TS
                                                                                                43
       PRINT 39
                                                                                           TS
                                                                                                114
       PRINT 40
                                                                                           13
                                                                                                45
                                                                                           TS
       2,54,5=I £ 00
                                                                                                46
       CG(I)=0.
TIME=-DT
                                                                                           TS
3
                                                                                                47
                                                                                           TS
                                                                                                48
C
                                                                                           TS
                                                                                                49
       BEGIN TIME LOOP
                                                                                           TS
                                                                                                50
C
C
                                                                                           TS
                                                                                                51
       DO 31 ITIME=1,NTSTEP
                                                                                           TS
                                                                                                52
                                                                                                53
       TIME=TIME+DT
                                                                                           TS
       ITLOC=(ITIME-1)+N2
                                                                                           13
                                                                                                54
                                                                                                55
C
                                                                                           TS
       SET UP APPLIED FIELD AT PRESENT TIME
                                                                                                56
                                                                                           13
```

```
C
                                                                                  TS
      CALL EINCF (TIME)
                                                                                       58
                                                                                   TS
       IF (ITIME.EQ.1) GO TO 18
                                                                                   TS
                                                                                       59
      IF (ICFLG, EQ. 0) GO TO 5
                                                                                       60
C
                                                                                   TS
                                                                                       61
      COMPUTE FIELD AT PRESENT TIME DUE TO CURRENTS AT RETARDED TIMES
C
                                                                                   TS
                                                                                       65
                                                                                  TS
                                                                                       63
      NBKS=((NTMAX-K)+N2+NELO+NUCQ-1)/NOCQ+1
                                                                                  13
                                                                                       64
       IF (NBKS.GT.NBOUT) NBKS=NBOUT
                                                                                  TS
                                                                                       65
      NBAS=NELO-NBKS+NOCQ+NOCO
                                                                                  TS
                                                                                       66
      DO 4 J=1, NBKS
                                                                                       67
      BACKSPACE
                    11
                                                                                  TS
                                                                                       63
      READ (11) NIN, (CQ(J), J=1, NOCQ)
                                                                                  TS
                                                                                       69
       N9IN=1
                                                                                  13
                                                                                       70
      1F (10c.EQ.0) GO TO 7
5
                                                                                  13
                                                                                       71
      REWIND 12
READ (12) ICL, LEND, (COF(J), J=1, ICL)
                                                                                  TS
                                                                                       72
                                                                                  TS
                                                                                       73
       IF (ITIME.LE.LEND) GO TO 6
                                                                                  TS
                                                                                       74
7
      ESCATEO.
                                                                                  TS
                                                                                       75
       ICF=1
                                                                                  13
                                                                                       76
       Isi
                                                                                       77
                                                                                  73
       INDX=ICOF (ICF)
8
                                                                                  TS
                                                                                       78
      ICF=ICF+1
                                                                                  TS
                                                                                       79
      IF (INDX.LT.0) GD TO 9
ICF=ICF+INDX/10000
                                                                                  TS
                                                                                       80
                                                                                  TS
                                                                                       81
       GO TO 8
                                                                                  TS
                                                                                       82
      IF (ITIME, LE. (-INDX/10000)) GD TO 8
                                                                                  TS
                                                                                       83
      GO TU 11
                                                                                  13
                                                                                       84
10
      EINC(1)=EINC(1)+ESCAT
                                                                                  TS
                                                                                       85
      ESCAT=0.
                                                                                  TS
                                                                                       86
      IF (INDX, EQ. 0) GO TO 18
11
                                                                                  TS
                                                                                       87
       INDX=-INDX
                                                                                  TS
                                                                                       88
       K=1NDX/10000
                                                                                  TS
                                                                                       89
      1=1NDX-K+10000
                                                                                       90
                                                                                  13
      K=ITIME-K
                                                                                  13
                                                                                       91
12
       ICGB=(K-1) +N2-NBAS
                                                                                  13
                                                                                       92
       IF (ICOB.LT.IOLIM) GO TO 14
                                                                                  TS
                                                                                       93
      IF (NAIN, EG, NBKS) GO TO 14
                                                                                  13
                                                                                       94
      READ (11) NIN, (CQ(J), J=1, NOCO)
                                                                                       95
                                                                                  TS
      NBIN=NBIN+1
                                                                                  TS
                                                                                       96
      NBAS=NBAS+NOCO
                                                                                  TS
                                                                                       97
      GO TO 12
IF (ICF.LE.ICL) GO TO 14
                                                                                      98
                                                                                  TS
13
                                                                                  TS
                                                                                       99
       READ (12) ICL, LEND, (COF (J), J=1, ICL)
                                                                                  TS 100
      ICF=1
                                                                                  TS 101
       INDX=1COF(ICF)
                                                                                  TS 102
       ICF=ICF+1
                                                                                  TS 103
      IF (INDX.LE.0) GO TO 10
                                                                                  TS 104
      J1=1N0x/10000
                                                                                  TS 105
       J2=I*Dx-J1+10000
                                                                                  18 106
       ICU=ICUB+J2
                                                                                  TS 107
      IF (K.EG. ITIME) GO TO 16
                                                                                  TS 108
      00 15 3=1.31
                                                                                  TS 109
      ESCATELECAT+COF(ICF)+CO(ICG)
                                                                                  TS 110
      ICQ=ICQ+1
                                                                                  TS 111
                                                                                  TS 112
15
      ICF=ICF+1
      GO TO 13
                                                                                  15 113
                                                                                  TS 114
                                                                                  TS 115
TS 116
      ICF=ICF+1
      DO 17 J=1,J1,2
```

```
ESCAT=FSCAT+COF(ICF)+CQ(ICQ)
                                                                               TS 117
      ICO=ICQ+2
                                                                               TS 118
17
      1CF=ICF+2
                                                                               13 119
      ICF=ICF-1
                                                                              TS 120
      GO TO 13
                                                                              15 121
C
                                                                              18 122
C
      SOLVE MATRIX EQUATION FOR CURRENTS AT PRESENT TIME
                                                                              TS 123
C
                                                                              15 124
      IF (INT.EQ.0) GO TO 19
                                                                               TS 125
18
      CALL LISOLV (CURF, CURF, N, IX, EINC)
                                                                              79 126
      05 DT 09
                                                                              75 127
19
      CALL SOLVE (N, CURF, IP, EINC, N)
                                                                              TS 128
      PRINT 41.
20
                  ITIME, TIME, (EINC(I), I=JP1, JP2)
                                                                              13 129
      PRINT 43, ESRC
                                                                              TS 130
         (ITIME.GT.NTRAN) GO TO 21
                                                                              TS 131
      ESORC (ITIME) = ESRC
                                                                               TS 132
      ICU=ITLUC-1-NELO
                                                                               TS 133
      DO 55 1=1'N
                                                                              TS 134
      100=100+5
                                                                               TS 135
      ICGB=ICG+1
                                                                              TS 136
      CQ(ICQ)=EINC(I)
                                                                              TS 137
      CQ(ICQ8)=CQ(ICQ8)+QI3*EINC(1)
                                                                               TS 138
      IF (ITIME, EQ. NTSTEP) GO TO 31
                                                                              TS 139
      IF (1008.LT.LCQ) GO TO 26
                                                                              TS 140
      IF (1000.EU.1) GO TO 23
                                                                               TS 141
      IOCQ=1.
                                                                              TS 142
      REWIND
                                                                              TS 143
      IF (L1.EG.1) GO TO 23
                                                                              TS 144
      WRITE (11) NOCQ, (CQ(1), 1=1, NOCQ)
                                                                              TS 145
      I+TUDBA=TUDBA
                                                                              75 146
      ICFLG=1
                                                                              13 147
      IOLIM=NUCQ
                                                                              TS 148
      WRITE (11) NOCO, (CO(1), I=L1, L2)
                                                                              TS 149
23
      NBOUT=NBOUT+1
                                                                              TS 150
      NELO=NELO+NOCO
                                                                               TS 151
      IF (L1.EQ.1) GO TO 24
                                                                              18 152
      ICI=NS-NOCO
                                                                              TS 153
      1C2=N4P-NOCO
                                                                              TS 154
      92 DI 09
                                                                              TS 155
      00 25 1=1,NSFT
                                                                              TS 156
24
      INUX=I+NUCQ
                                                                              TS 157
25
      CQ(1)=CQ(1NOX)
                                                                              TS 158
      NBAS=NELO
                                                                              TS 159
      ICG=ITLUC-NELO+NZ
56
                                                                              TS 160
                                                                              TS 161
TS 162
      COMPUTE COMPONENT OF TIME INTEGRAL OF CURRENT AT NEXT TIME STEP
C
      THAT DEPENDS UN PRESENT AND PAST VALUES OF CURRENT AND
                                                                              TS 163
      TIME INTEGRAL OF CURRENT
                                                                              15 164
C
                                                                              TS 165
      1F (1TIME, EQ. 1) GO TO 28
                                                                              13 166
      DO 27 J=1,N
                                                                              15 167
                                                                              15 168
      100=100+5
      ICGx=ICG-IC1
                                                                              15 169
      ICOA=ICO-ICS
                                                                              15 170
      CO(1CO) = CO(1COx) + G11 + CO(1COY) + O12 + EINC(J)
27
                                                                              TS 171
      60 10 30
                                                                              15 172
      00 29 J=1.N
85
                                                                              TS 173
      100=100+5
                                                                              TS 174
      100x=100-101
                                                                              18 175
      CO(ICU)=CO(ICOX)+GIZ+EINC(J)
29
                                                                              TS 176
```

```
IF (IC1.EQ.N2) IC2=N4P
30
                                                                                    TS 177
      IC1=N2
                                                                                    TS 178
      CONTINUE
31
                                                                                    TS 179
       IF (10CU.EU.O) GO TO 34
                                                                                    TS 180
      IF (L2.GE.ICOB) GO TO 33
32
                                                                                    TS 181
       WRITE (11) NOCO, (CQ(1), I=L1,L2)
                                                                                    18 182
       NBOUT=NBOUT+1
                                                                                    TS 183
       F1=F5+1
                                                                                    TS 184
       TS=FS+NOCO
                                                                                    TS 185
       GO TO 32
                                                                                    13 186
33
      NOC0=1CG8-L1+1
                                                                                    TS 187
       WRITE (11) NOCG, (CG(I), I=L1, ICO8)
                                                                                    TS 188
      NBOUT=NBOUT+1
                                                                                    TS 189
       REWIND
                                                                                    TS 190
                11
       IF (IOC.NE.O) REWIND
34
                                                                                    TS 191
                               12
       RETURN
                                                                                    13 192
      PRINT 42.
35
                                                                                    TS 193
       STOP
                                                                                    TS 194
                                                                                    TS 195
                                                                                    TS 196
C
                    1X.49HSOLUTION WILL USE CURRENTS FROM CORE STORAGE ONL
      FORMAT (
36
                                                                                   TS 197
      14)
                                                                                    TS 198
      FORMAT ( 1x,44HSOLUTION WILL USE CURRENTS FROM FILE STORAGE)
FORMAT (1x,33HLENGTH OF CURRENT OUTPUT BLOCK IS,18,1x,6HHORDS.,/,
37
                                                                                    TS 199
38
                                                                                   TS 200
      11X, 42HNUMBER OF TIME STEPS USED DURING SULUTION=, 18, //)
                                                                                    TS 201
      FORMAT ( 44x,32H- - - - CURRENT SOLUTION - - - - - - - - )
FORMAT (1x,4MSTEP,6x,4MTIME,5x,52MSEGMENT CURRENTS IN AMPS (READ
39
                                                                                    18 505
40
                                                                                    TS 205
      TS 204
      ZEACH BLOCK REPRESENTS SOURCE STRENGTH)
                                                                                    TS 205
      FORMAT (/,1x,14,812,5,10811,3,/,(17x,10811,3))
FORMAT (1x,72+***ERROR - HOUTINE TSOL-- INSUFFICIENT STORAGE FOR
41
                                                                                    TS 206
                                                                                   TS 207
42
      ISEGMENT CURRENTS. N=, 110)
                                                                                    TS 208
      FORMAT (19x, 10HEXCITATION, E13.4)
                                                                                   TS 209
43
       END
                                                                                    TS 210-
```

```
SUBROUTINE WIRE (XW1, YW1, ZW1, XW2, YW2, ZW2, RAD, NS, ITG)
                                                                                  WI
                                                                                  WI
000
                                                                                       3 4
      SUBROUTINE WIRE GENERATES SEGMENT GEOMETRY DATA FOR A STRAIGHT
                                                                                  M I
      WIRE OF NS SEGMENTS.
                                                                                  WI
                                                                                       5
                                                                                  WI
      CDMMON /DATA/ N,NP, X(200), Y(200), Z(200), SI(200), BI(200), ALP(200),
                                                                                  WI
        BET(200), ICUN1(200), ICON2(200), ITAG(200), IPX, IPY, IPZ
                                                                                  HI
                                                                                       7
      DIMENSION X2(1), Y2(1), Z2(1)
                                                                                       8
                                                                                  WI
      EQUIVALENCE (x2(1), SI(1)), (Y2(1), ALP(1)), (Z2(1), BET(1))
                                                                                  HI
                                                                                       9
                                                                                      10
      IST=N+1
                                                                                  HI
                                                                                  WI
      RH+NS
                                                                                      11
      NPaN
                                                                                  #I
      IF (NS.LT.1) RETURN
                                                                                  WI
                                                                                      13
      FNS=NS
                                                                                  WI
                                                                                      14
      XD=(XW2-XW1)/FNS
                                                                                  hI
                                                                                      15
      YD= (YW2-YW1)/FNS
                                                                                  w I
                                                                                      16
      ZD=(ZA2-ZW1)/FNS
                                                                                  w 1
                                                                                      17
                                                                                  WI
      XE1=XW1
                                                                                      18
                                                                                      19
                                                                                  WI
      Y31=YW1
      ZS1=Z#1
                                                                                  WI
                                                                                      20
      DO 1 I=IST, N
                                                                                  h I
                                                                                      51
      ITAG(I)=ITG
                                                                                  #I
                                                                                      55
                                                                                      23
                                                                                  WI
      xSZ=XS1+XD
                                                                                  WI
                                                                                      24
      Y32=Y51+YD
                                                                                  WI
      Z32=Z51+Z0
                                                                                      25
                                                                                  WI
      x(1)=XS1
                                                                                      26
                                                                                  WI
      Y(1)=YS1
                                                                                      27
      7(1)=251
                                                                                  WI
                                                                                      29
                                                                                  WI
                                                                                      29
      x2(1)=x32
      Y2(1)=YS2
                                                                                  WI
                                                                                      30
                                                                                  WI
      Z2(1)=Z32
                                                                                      31
                                                                                  WI
      BI(I)=RAD
                                                                                      35
                                                                                  41
                                                                                      33
      x51=x52
      YS1=YS2
                                                                                  WI
                                                                                      34
                                                                                      35
      Z$1=Z$2
                                                                                  14
                                                                                      36
      RETURN
      END
                                                                                      37-
```

### APPENDIX B DIAGNOSTICS

1. BLOCKING N<sub>1</sub> N<sub>2</sub> N<sub>3</sub>

Routine: FBLOCK

This is printed when matrix factorization and solution requires file storage. It does not indicate an error.

N, = number of blocks on file storage

N<sub>2</sub> = number of matrix columns per block

 $N_3$  = number of matrix columns in last block  $(N_3 \le N_2)$ 

2. CHECK DATA, PARAMETER SPECIFYING SEGMENT
POSITION IN A GROUP OF EQUAL TAGS MUST NOT BE
ZERO

Routine: ISEGNO

The number following the tag number reference on a data card was zero. Execution terminated.

3 ERROR FLAG RETURNED BY SUBROUTINE FORT,

IFERR = ---

Routine: ITOF

This indicates a program malfunction. The meaning of IFERR is explained in the comments in subroutine FORT.

4. ERROR - ROUTINE RFLD -- INCONSISTENT SEGMENT CONNECTION DATA

Routine: RFLD

This indicates a program malufaction. The connection information in arrays ICON1 and ICON2 was found to be contradictory. A possible cause is an overflow of an array.

5. ERROR - ROUTINE TSOL -- IN SUFFICIENT STORAGE FOR SEGMENT CURRENTS. N = ---

Routine: TSOL

The dimension of array CQ must be at least  $4 \times N$  where N is the number of segments. This dimension is presently 6400 for the GE 635/645 computer and 5184 for the CDC 3800.

6. GEOMETRY DATA CARD ERROR Routine: DATAGN An invalid mnemonic was found on a card where a geometry data card was expected. 7. INCORRECT LABEL FOR A COMMENT CARD Routine: MAIN An invalid mnemonic was found on a card where a comment card was expected. INPUT ENERGY NOT COMPUTED SINCE SOURCE HAS 8. BEEN TRANSFORMED Routine: MAIN Request for energy budget must preceed any requests involving Fourier transforms since the Fourier transform writes over the record of the source time function. INTEGRATION ATTEMPTED OVER SINGULARITY. 9. B, C = ---Singularity due to R going to zero in range of integration  $(R = s^2 + Bs + C)^{1/2}$ ). Possible cause is overlapping segments in geometry specification. 10. INVALID DATA CARD LABEL AFTER SOLUTION Routine: MAIN An invalid mnemonic was found on a card where a data request card was expected. Valid mnemonics are EB, PC, AT, RF, NX, and EN NO SEGMENT HAS AN ITAG OF ---11. Routine: ISEGNO TAG number used to refer to a segment does not exist. NUMBER OF EXCITATION VALUES EXCEEDS ARRAY 12. DIMENSION Number of voltage sources cannot be greater than the

dimensions of EMAG and ISRC. Dimension is now 10.

13. OVERFLOW IN FILLING ARRAY COF

Routine: COFS

This indicates a program malfunction. May possibly be corrected by increasing IST at statement CF 34A in subroutine COFS to cause more frequent dumping of data to file.

OVERFLOW IN FILLING ARRAY SRT 14. Routine COFS

Same as 13.

PIVOT(---) = ---15.

Routine: FACTR or LFACTR

This will be printed during Gauss Doolittle factoring of the interaction matrix when a pivot element less than 10<sup>-10</sup> is encountered, and indicates that the matrix is nearly singular. The number in parenthesis shows on which pass through the matrix the condition occurred. This is usually an abnormal condition although execution will continue. It may result from coinciding segments or a segment of zero length.

RETARDED TIMES FROM SEGMENT --- TO SEGMENTS ---16.

AND--- DIFFER BY---TIME STEPS

Routine: COFS

Retarded times from a point to two segments which are connected to each other cannot differ by more than one time step. This is usually caused by a segment with length greater than the time increment multiplied by the velocity of light.

RETARDED TIMES TO SEGMENTS --- AND --- DIFFER 17.

BY---TIME STEPS

Routine: RFLD

Same as 16.

18. SEGMENT --- LIES IN OR BEHIND SYMMETRY PLANE
Routine: CONECT
All segments must lie on the positive side of any symmetry

planes.

19. SEGMENT CONNECTION ERROR. J = ---

Routine: COFS

Same as 4. Error detected at segment J.

20. ZERO TIME STEPS REQUESTED

Routine: MAIN

Both TMAX and NTSTEP on First data card were zero

or blank.

Appendix C
List of Scientific Subroutines Used in TIMDOM

Dist	-	Scientific Subjournes Osed in Thirbow
ABS(X)	=	absolute value of X
AIMAG(Z)	=	imaginary part of the complex number Z,
		(result is real)
AINT(X)	=	integer truncation (result is real)
ALOG(X)	=	the natural log of X
ALOG10(X)	=	the log to the base ten of X
ASIN(X)*		arcsine of X, result in radians
$ATAN2(X_1, X_2)$	=	arctangent of X1/X2, result in radians covering
		all four quadrants.
CEXP(Z)	=	complex exponential (e <sup>Z</sup> )
CMPLX $(X_1, X_2)$	=	formation of a complex number $(Z = X_1 + j X_2)$
CONJG(Z)	=	conjugate of the complex number Z
COS(X)	=	cosine of X
DABS (X)	=	absolute value of a double precision number
		(result is double precision)
DATAN (X)	=	arctangent of a double precision number (result
		is double precision)
DLOG (X)	=	natural log of a double precision number (result
		is double precision)
DSQRT (X)	=	square root of a double precision number (result
		is double precision)
EXP (X)	=	exponential function (e <sup>x</sup> )
FLOAT (K)	=	real number equivalent of integer K
IABS (I)	=	absolute value of integer I
REAL(Z)	=	real part of the complex number Z
SIGN $(X_1, X_2)$	=	sign of X <sub>2</sub> times  X .
SIN (X)	=	sine of X
SQRT(X)	=	square root of X

\* Note, this routine is not found in the Honeywell/GE scientific library; therefore, it is included as a subroutine in the TIMDOM deck for this machine.

### METRIC SYSTEM

BA	S	R	ı	м	п	8

Quantity	Unit	SI Symbol	Formula
length	metre	m	
mass	kilogram	kg	
time	second	Carlotte South and All Carlotte	
electric current	ampere	٨	***
hermodynamic temperature	kelvin	K	
amount of substance	mole	mol	
uminous intensity	candela	cd	
SUPPLEMENTARY UNITS:			
plane angle	redian	rad	
solid angle	steradian	18	
DERIVED UNITS:			
Acceleration	metre per second squared		m/s
activity (of a radioactive source)	disintegration per second	***	(disintegration)/s
angular acceleration	radian per second squared		rad/s
angular velocity	radian per second	***	red/s
ares	square metre	***	m
density	kilogram per cubic metre		kg/m
electric capacitance	farad	F	A-s/V
electrical conductance	siemens	S	AN
electric field strength	volt per metre		V/m
electric inductance	henry	н	V-VA
electric potential difference	volt	V	W/A
electric resistance	ohm		V/A
electromotive force	volt	V	W/A
energy	joule		N-m
entropy	joule per kelvin		J/K
force	newton	N	kg-m/s
frequency	hertz	Hz	(cycle)/s
illuminance	lux	lx	lm/m
luminance	candela per square metre		cd/m
luminous flux	lumen	lm	cd-sr
magnetic field strength	ampere per metre		A/m
	weber	Wb	V-s
magnetic flux magnetic flux density	tesla	T	Wb/m
	ampere	۸	
magnetomotive force	watt	w	l/s
power	pascal	Pa	N/m
pressure	coulomb	C	A-s
quantity of electricity	ioule	i	N-m
quantity of heet	watt per steradian		Wist
radiant intensity	joule per kilogram-kelvin		I/kg-K
specific heat	pascal	Pa	N/m
stress			W/m-K
thermal conductivity	watt per metre-kelvin metre per second		m/s
velocity	pascal-second		Pa-s
viscosity, dynamic			m/s
viscosity, kinematic	square metre per second	Ÿ	W/A
voltage	volt		m
volume	cubic metre	***	(wave)/m
wavenumber	reciprocal metre	·	N·m
work	joule		

#### SI PREFIXES:

Multiplication Factors	Prefix	SI Symbol
1 000 000 000 000 = 1012	tera	Т
1 000 000 000 = 104	gige	G
1 000 000 = 10^	mega	M
1 000 = 103	kilo	k
100 = 102	hecto*	h
10 = 101	deka*	de
$0.1 = 10^{-1}$	deci*	d
0.01 = 10-2	centi*	C
0.001 = 10-1	milli	m
0.000 001 = 10-4	micro	μ
0.000 000 001 = 10-4	neno	n
0.000 000 000 001 = 10-12	pico	D
0.000 000 000 000 001 = 10-14	femto	
0 000 000 000 000 001 = 10-10	etto	

<sup>\*</sup> To be avoided where possible.

0.000